With the Author's
kind regards

May 5. 1854

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THE

AMERICAN TEXT BOOK

OF PRACTICAL AND SCIENTIFIC

AGRICULTURE,

INTENDED FOR THE USE OF

COLLEGES, SCHOOLS, AND PRIVATE STUDENTS;

AS WELL AS FOR

THE PRACTICAL FARMER.

INCLUDING

ANALYSES BY THE MOST EMINENT CHEMISTS.

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TO

DR. SILAS H. DOUGLASS;

PROFESSOR OF CHEMISTRY, GEOLOGY, MINERALOGY, &C., IN THE

UNIVERSITY OF MICHIGAN;

TO WHOSE EXERTIONS AND ENERGY, THE

ESTABLISHMENT OF AGRICULTURAL LECTURES

IN THAT INSTITUTION,

IS,

TO A GREAT EXTENT, DUE.

AND WHO, FROM AN EARLY DAY, HAS EARNESTLY

AND PERSEVERINGLY LABORED IN THE CAUSE OF SCIENCE IN

THIS STATE:

THIS VOLUME

IS DEDICATED BY HIS MOST SINCERE AND

OBLIGED FRIEND

THE AUTHOR.

PREFACE.

THE following work is strictly what it professes to be—A TEXT BOOK. It is not intended so much to teach the Science and Art of Agriculture, as to enable the Teacher to teach. In its character it is *suggestive*, and makes no pretensions to be a perfect Encyclopœdia of the subject. At the same time it is believed that there is no point—so far as the work professes to go—on which it is important that the Teacher should enlarge, or the student learn, to which they will not find their attention directed. Nor will the experienced Farmer, or the general reader fail to be interested. Practice and science are brought together, and compelled to assist each other; instead of being unnaturally divorced, as, unhappily, they have too long been in this department of knowledge.

This little work is the offspring of a sorely felt necessity. A year since, the Author was unexpectedly called upon to deliver a course of lectures on Agriculture, before the newly organized "Scientific Department" of the University of Michigan. He had for some years studied the subject, both practically and theoretically, and collected a valuable library in connection with it. But this he had done merely for his own gratification, without any direct object in view, and certainly with no intention of ever becoming a teacher of Agriculture. A sense of duty to the public would not allow him to refuse the invitation; and

painfully conscious of his deficiencies, he assumed the office, determined to do the best he could. Upon the very threshold, however, he met with an unexpected difficulty. He could find no book, published either in America or Europe, adapted for a collegiate class, many of whom were practical and middle-aged farmers, and some to whom the very terms of Science were unknown. Professors Johnston, Norton, and Nash have each published elementary works, most excellent so far as they go; but they are confined almost entirely to the *chemical* portion of the subject, and "Practical Agriculture in its connection with Science" was the topic demanded. There are other books again, but deficient on the other side,—consisting merely of directions how to cultivate the land,—being chiefly compilations, and making no pretensions to a higher or scholastic character; so that the Author was obliged to prepare and write his entire course of lectures, and the students lost much from the want of some work which they might study in private, or refer to from time to time. This loss was chiefly felt in regard to analyses, figures and scientific words. It is quite impossible that a student can understand the one, or recollect the other by merely hearing them; and yet if these portions are lost, much of the value of the succeeding information is lost likewise.

Within the few last years, the study of Agriculture in the United States, has assumed a new form. It is beginning to be introduced, not only into Colleges, but also into Primary Schools; and in conversing with other gentlemen, the Author found that this want was as sensibly deplored by others, as it had been by himself. He therefore undertook to write out the substance of his lectures. Neither his more important engagements, nor his

health permitted him to anticipate more. But having made a beginning, he found the subject constantly enlarging, and he has, to the best of his ability, collected and arranged a synopsis of all that is known,—so far as he could ascertain it—of the theoretical and practical truths and principles of Agriculture, up to the present moment. The analyses which are given, are, it is believed, the very latest that have been made, and, perhaps without exception, are worthy of all credit in the present position of the Science. The more strictly technical portion is either the result of the Author's own experience and experiments, or it is compiled from the most trustworthy sources adapted to the present position and necessities of the American Famer.

The only novelty, which can be claimed as such, is the arrangement, each subject being complete within itself. Much more might have been introduced, and one of the chief difficulties that have been experienced has been compressing the matter,—the omitting of all which did not appear to be absolutely necessary for the object in view, and the using as few words as possible.

It was essential that the book should be of moderate size, and cheap—this the Publisher insisted upon as a *sine qua non*,—and consequently much that might have been inserted has been left out. Thus, it is taken for granted that the Teacher or the Student is already familiar with Botany, and the elements of Agricultural Chemistry. Had these topics likewise been introduced further than they have been, they would have swelled the work far beyond the requisite size. For the boundaries of agricultural knowledge are like those of the horizon, ever enlarging as we travel on, till they embrace almost the entire circle of

the sciences and Arts. So vast are the subjects, that a writer attempting to include the whole, would find that a library, not a volume, would be the result of his labors. Besides, with the excellent elementary works already mentioned, and Prof. Gray's Botanical Text-book, repetition could not have been avoided, and this too, has been most scrupulously abstained from, as regards works in general circulation among us. So again, the topics treated upon in the early chapters are presented merely in outline. Agricultural Meteorology—though essentially a most interesting and important application of Science,—is yet in its earliest infancy; and the materials do not exist for accurate or extended instruction; while the Natural History of Plants, the Air, Water, &c., belong rather to the department of the Chemist and the Vegetable Physiologist, than to the practical Agriculturist. Enough only is written on these subjects to serve as an introduction to what follows.

In many instances, and always in the Analyses, the authority quoted is mentioned, chiefly in order that the Teacher may be able to refer directly to the original, where he will usually meet with a more complete elucidation of the subject than could be admitted into these pages.

It will be observed that the work is printed in type of *three sizes.* Those portions which are considered as peculiarly important, or as being capable of comprehension by students of all ages, are printed in the largest type; that which is abstruse is in a second sized; and that which peculiarly interests the practical farmer is in the smallest type. The Chapters are likewise so arranged as to permit the teacher to select such subjects as he chooses.

No one can attempt to teach an irregular science, or a "scientific art" such as Agriculture is rapidly becoming, without discovering how much he must depend for explanation and illustration on his own resources. The strict sciences, such as mathematics, may be entirely taught by books; but in agriculture there is still so much that is uncertain, and so many sciences and arts are combined within it, that—without taking into consideration the discoveries that are almost daily made—a lifetime, laboriously devoted to the subject could scarcely render one individual master of the whole. It is hoped, therefore, that the Teacher who may use this book will enlarge upon the various subjects, and explain that which is difficult—in one word, that he will consider it as the mariner does his chart, as a director of his course, but a director from which he is at liberty to differ should his superior experience and knowledge induce him to do so.

The Author has no desire to assume to himself more credit than is due, nor to make excuses which are not strictly true. But constantly and seriously occupied in various other duties; for a length of time at a distance from the Press; and compelled to search for materials in a large number of books—considerably over one hundred volumes having been consulted and compared—he has not only found the labor of compiling these sheets a very arduous one, but is well aware, that had he been able to devote more time to the object he could have rendered them more truly worthy of the acceptance of the public. Should another Edition be called for, many emendations will probably be made.

The limits of this volume forbid the subject of Domestic

Animals, and some other topics being touched upon. For another work, a large amount of materials is on hand, and should life and health be spared, the writer may, perhaps, include them in another volume. That, however, must depend upon the success with which this meets.

University, Ann Arbor, Mich.,
Feb. 14, 1854.

CHAPTER I.

INTRODUCTORY.

1. The word AGRICULTURE is derived from two Latin words, AGER, *a Field*, and CULTURA, *Cultivating* or *Tilling*. It therefore means, strictly, *The working of the soil;* but is now used to describe every process connected with Farming.

2. Agriculture may be divided into *(a,)* growing of grains; of edible plants; of oil bearing plants; of vegetables used in dying, &c.; *(b,)* of grasses; *(c,)* breeding of stock; *(d,)* fattening of stock; *(e,)* producing wool; *(f,)* manufacture of cheese and butter; *(g,)* cultivation of fruit; *(h,)* of vegetables and flowers; *(i,)* viticulture, (or the culture of the grapevine,) and wine making; *(j,)* *Planting*, or the production of cotton, rice, sugar, tobacco, &c. And, in Europe, to the above are added, *(k,)* forest matters; *(l,)* manufacture of beet sugar; *(m,)* the production of silk; and of some other minor articles.

3. Any of these processes may be pursued by itself; though, in most instances, it is found profitable to include more than one of the above divisions on the same farm. In this respect, agriculture differs from manufactures; the latter becoming more profitable as the division of labor becomes more simple.

4. Agriculture is an ART, which, to be truly understood, requires the study of many SCIENCES.

ART is the application of knowledge to practical purposes. *Science* is a knowledge of the principles of Art. If the knowledge be merely ac-

cumulated experience, its application is ***empirical art;*** but if it be experience reasoned upon and brought under general principles, it assumes a higher character, and becomes a ***scientific art.***

5. The following are usually considered the Sciences which are naturally included in the Art of Agriculture:—I. *Mathematical Science: (a,)* arithmetic; *(b,)* algebra; *(c,)* geometry; *(d,)* mechanics; *(e,)* surveying; *(f,)* levelling; *(g,)* stereometry, *(the measuring of solid bodies,) (h,)* linear drawing. II. *Physical and Natural Sciences: (a,)* physics; *(b,)* meteorology; *(c,)* mineral chemistry; *(d,)* mineralogy; *(e,)* geology; *(f,)* botany. III. *Technological Sciences: (a,)* organic chemistry; *(b,)* scientific agriculture; *(c,)* arboriculture; *(d,)* sylviculture; *(e,)* vegetable and animal physiology; *(f,)* veterinary art; *(g,)* zoology; *(h,)* equitation. IV. *Noological Sciences: (a,)* rural architecture; *(b,)* forest economy; *(c,)* book-keeping; *(d,)* rural economy; *(e,)* rural law. Each of these, again, is divisible into several sub-divisions; and the list may be still further added to with practical advantage.

6. While a knowledge of all these sciences is necessary to the thoroughly educated farmer, only a part of them is included in what is commonly termed *practical* agriculture. Of this latter portion, meteorology, chemistry, geology, mineralogy and botany, are usually taught by themselves; leaving field-work, arboriculture, animal physiology, zoology, and veterinary art in a class by themselves. To these last, the following pages will be devoted. It must, however, be observed, that so closely are the majority of these sciences interwoven in forming the agricultural art, that it is impossible entirely to disconnect the one from the other. This is especially the case with chemistry and botany: a knowledge of the principles of which must be considered as absolutely essential, and which, together with certain departments of geology, must be frequently referred to.

7. The farmer is a manufacturer. His art converts the soil and air into grain, meat, wool, oil, and other substances. He creates nothing:

he only causes a change of arrangement of materials already existing; which materials are governed by known and fixed laws. What the farmer, therefore, requires, is an intimate acquaintance with these materials, and with the natural laws to which they are subject. The earth and air are composed of a certain number of simple elements. But in this primitive shape, they are unfit for the support of animal life. Yet they will become either weeds or useful plants, according to the mode in which they are used. Again, if they become the latter, the quality produced on a given area will be large or small according to known and fixed rules; and if domestic animals are reared, these will be large or small, healthy or unhealthy, according to the same certain and unalterable laws. It depends, therefore, upon the knowledge which the practical farmer has of these laws, and the use he makes of this knowledge, whether he receives the largest possible return for his labor or not.

8. The object of the practical farmer is to raise from a given area of land the largest quantity of the most profitable produce at the least cost; and not only to avoid impoverishing the soil, but to render it gradually more productive. A knowledge of the above named sciences will enable him to do this; and thus he is repaid pecuniarily for the labor of his mind, as the workman is repaid for the labor of his body.

10. The earliest effort in Europe for the establishment of an Agricultural School, was made by M. L'Abbe Rosier in 1775; but, owing to the neglect of the government, it failed to go into operation. In 1799, Fellenberg, of Switzerland, established the Hofwyl School, which appears to have been the first institution of the kind. In 1818—1822, M. de Domsbasle commenced a Model Farm, of 375 acres, in connection with a place of education, at Roville, in France. In 1827, the Royal Agronomic Institution of Grignon, near Paris, was commenced, by the government. It owns a farm of 1,250 acres, and receives yearly a grant of about $12,000. In Germany, in 1806, the celebrated Dr. A. D. Thaer opened an Agricultural Academy at Moegelin, in Prussia, to educate superintendents for large estates. In 1845, the Royal Agricultural College of Cirencester, England, was chartered. Such institutions are now abundant in every part of Europe.

11. Dr. E. Hitchcock, in the "Report of Commissioners to the Commonwealth of Massachusetts concerning an Agricultural School, *January*, 1851," gives the following list of Agricultural Educational Establishments in Europe:

SCHOOLS.	Superior Schools.	Intermediary Schools.	Inferior Schools.	Special Schools.	Connected with Colleges & Universities	Total.
In England, - - -	1		4			5
In Ireland, - - - - -	1	25	34		3	63
In Scotland, - - -					2	2
In France, - - - -	5		70			75
In Italy, - - - - -			1		1	2
In Belgium, - - - -		3	2	1	3	9
In Prussia, - - - - -	3	2	12	13	2	32
In Austria. - - - -	4		3	25	1	33
In Wurtemberg, - - -	1	2	1	3		7
In Bavaria, - - - -	1	1	32	1		35
In Saxony, - - - -	1	3		1		5
In Brunswick, - - -		1	1			2
In Mechlenburg Schwerin, -		1				1
In Schleswig Holstein, - -		2	2			4
In Anhault, - - - -	1	1				2
In Duchy of Hesse, - - -		2				2
In Duchy of Weimar, - -					1	1
In Duchy of Nassau, - -	1					1
In the Electorate of Hesse, -	1					1
In Duchy of Baden, - -		1				1
In Duchy of Saxe Meiningen,			1			1
In Russia, - - - - -	2	10	51	4	1	68
Total, - - - - -	22	54	214	48	14	352

12. Besides these, there are Colleges devoted to instruction in Veterinary Art, the most important of which are, the Imperial School at Alfort, in France, and the Royal College of Veterinary Surgeons, in London. In these institutions, a very complete education is afforded. Veterinary Colleges were first organized in France and Germany, in the beginning of the eighteenth century; and a great many valuable works from the pens of eminent practitioners have appeared on this subject. The first English College owes its origin, in 1792, to a Frenchman of the name of Saint Bel. In France, Veterinary Surgeons hold a high professional and social position, and many of them are members of the Order of the Legion of Honor. These schools, as well as the agricultural, receive annually liberal grants of money from government. One point of great importance is, that a Hospital for diseased animals is connected with each College, so that not only have the students an opportunity of studying living pathology; but, on the appearance of an endemic, there is great probability of the cause and cure being ascertained speedily.

13. Agricultural education is necessarily divided into the *theoretical* and the *practical*—or the Science of Agriculture and the Art of Agriculture. The former involving the reasons of action, is properly learnt first; and may be imparted without any connection with a farm; the second, including, as it does, manual dexterity, comparison, and experiment, must necessarily be taught in the field. Or the two may be taught simultaneously. There appear, however, in many cases, to be serious reasons against the latter course. A student of law or medicine first completes his *theoretical* education, and then proceeds to practice; and this seems to be the most rational course in agricultural education also. In the higher European Colleges, lectures are given in the field, *after* a large amount of information has been acquired; but, it is believed, that the students are not required to labor. There is certainly no efficient reason why a student of agriculture must necessarily spend a given portion of his time in physical toil; the more especially, as the manual operations of a farm are intrinsically simple, are easily learned, and require rather the exercise of the muscles than of the mind. A museum of rural objects, including models of implements, with likenesses of the best stock; and a hospital for diseased animals; connected with occasional visits to the best farms in the neighborhood, and to agricultural fairs, will supply everything that is requisite for the full education of a young man brought up on a farm; the practical skill being acquired when he returns home, to make agriculture the serious occupatian of his life.

CHAPTER II.

PLANTS.—THE AIR.—WATER.

14. Plants are formed by a re-arrangement of simple substances, (or elements,) already existing in *(a,)* the air, *(b,)* the water, and *(c,)* the soil. Animals are formed by a re-arrangement of these plants, of water, and of air. These changes are not simply mechanical, but chemical; and are under the direction of a power called LIFE, of which very little is yet known. Heat, light, electricity, the wind, the rain, and the sun, have also a powerful influence over vegetable and animal existence.

15. Wherever the proper elements and circumstances unite, there will vegetable life exist.

16. While all plants are composed of a certain quantity of different substances, the various orders of plants demand either a different proportion of the elements; or one requires an element which is not requisite to the existence of another plant. Thus, one species of plants grows in earth containing a large proportion of potash or soda, as wormwood *(artemisia)* and asparagus; while another requires little or no potash, as Indian corn. One grows in water, without any connection with the soil; while another grows in the air like the wind-plant of Florida; or the mistletoe of Europe, forcing its radicles into the sapwood of another tree.

17. While plants grow naturally where they find the elements, and other circumstances necessary for their formation;

they are also abundant or rare, according to the proportionate existence of these circumstances.

18. A plant not indigenous to a given locality, will grow and flourish, if transplanted, in exact proportion as it finds the materials and circumstances in its new locality the same as in its native one.

19. These facts are the ground-work of Agriculture as an intelligent art.

20. Comparatively few plants exist which are useful to man, and these, in their wild state, are naturally confined to narrow bounds. The business of the Farmer is, therefore, to cause such plants as he requires, to grow where he wishes them; and not only to grow, but by artificial adaptation of circumstances to compel them to yield so abundantly that their intrinsic value is greater than that of the labor bestowed upon them.

21. A striking example of this principle may be given in the growth of the Pine Apple in England. This is a plant requiring the heat of a long tropical summer in order that it may perfect its fruit. Until steamships plied between the West Indies and Great Britain, this fruit could not be carried to the latter country, without rotting. But so delicious is the flavor, that the English were not willing to be deprived of it. They consequently formed, by means of glass-houses and furnaces, a tropical atmosphere: they imitated the rich organic soil in which this plant is found to flourish; they supplied the moisture necessary at certain periods of growth; and not only brought the fruit to perfection, but greatly improved it in size and flavor.

22. The principles may therefore be laid down, *(a,)* "that out of nothing, nothing is made;" if it is desired to grow a given plant in abundance, all the elements that enter into that plant must be supplied in abundance, *(b,)* all other circumstances requisite to its perfection in its native state must also be furnished; *(c,)* that plants cannot be grown where these requisites are deficient; *(d,)* but that it is in the power of the Farmer, by

the acquisition of knowledge and by intelligent labor, so to modify existing circumstances as to cause a plant to grow profitably where naturally it could not do so.

23. On these simple principles, depends the utility of plowing, harrowing, manuring, irrigation, and the other mechanical processes of cultivation.

24. In other words, the art of Agriculture, when confined to growing plants, is simply adapting the soil, and surrounding circumstances to the natural demands of the plant; each plant varying somewhat from another, in its requirements.

25. In order to do this, it is necessary to understand, *(a,)* the materials which are or can be supplied by air, water, and soil; (for in this connection, manure is merely a modification of the soil,) *(b,)* the materials which enter into the composition of each plant; and *(c,)* the incidental changes, which meteorology and chemistry may produce.

26. THE AIR OR ATMOSPHERE.—According to M. Regnault, 100 cubic inches of atmospheric air, deprived of aqueous vapor and carbonic acid, weigh 30.82926 grains. At 62° Fahr. air is 810 times lighter than water, and 11,000 times lighter than mercury.

The chemical composition of air is, *(Dumas and Boussingault)*:—

		Air by Weight.	Air by Volume.
Oxygen,	Mechanically combined,	23.10	20.90
Nitrogen,		76.90	79.10
		100.00	100.00

—Besides these constituents, the atmosphere always contains a variable quantity of watery vapor and carbonic acid gas, besides other gasses and vaporous bodies which are observed to enter into it. The younger Saussure has ascertained that the mean proportion of carbonic acid is 4.9 volumes in 10,000 volumes of air; or almost exactly 1 in 2,000 volumes; but it varies from 6.2 as a maximum to 3.7 as a minimum, in 10,000 volumes.

Its proportion near the surface of the earth, is greater in summer than in winter, and during night than during day. It is also more abundant on the summits of high mountains than in the plains.

27. COMPOSITION OF DRY AIR BY VOLUME.—

Nitrogen, - - - - - - - -	7912
Oxygen, - - - - - - - - -	2080
Carbonic acid, - - - - - -	4
Carburetted hydrogen, - - - - -	4
Ammonia, (3 vols. of hydrogen with one of nitrogen,) - - - - - - - -	varies
Ozone, - - - - - - -	"
Organic matter, and salts, - - - - -	"

28. Prof. Horsford, in experiments made in Boston, Mass., in 1849, *(Am. Assoc. of Science,)* found the quantity of ammonia in the air greatly to exceed that detected by Fresenius, at Wiesbaden. Liebig, at Giessen, found it in rain-water and snow; and estimates that one pound of rain-water contains a quarter of a grain of ammonia.*

" A field of 26,910 square feet must receive annually upwards of 88 lbs. of ammonia; or 71 lbs. of nitrogen; for by the observations of Schubler, about 770,000 lbs. of rain falls over this surface in four months, and consequently the annual fall must be 2,310,000 lbs."—*Liebig, Agricul. Chemistry.*

Liebig assumes, and justly, that such salts as are found in rain water must have been held in suspension in the air, and washed out by the shower.

29. M. Barrall, of Paris, has lately examined the composition

* The following table exhibits the results of several determinations by Prof. Horsford, at Boston, Mass., of the relative quantities of ammonia found in rain and snow-water.

AMMONIA IN RAIN AND MELTED SNOW IN ONE CUBIC METRE.

1849—Dec'r 22, in rain,	1.56 grains.		1850—March 18, in snow,	1.49 grains.
" 29, in snow,	2.63 "		" 22-3, in snow,	0.96 "
1850—April 4, in rain,	0.24 "		July 16, in rain,	1.29 "
" 4, in snow,	0.72 "			

Annual of Scientific Discov. 1851, *p.* 234.

of rain water; and from these examinations we find that if we take the annual depth of rain to be about 24 inches, this quantity conveys to every acre of land the following substances:—

Nitrogen, - - - - - -	45½ lbs.
Nitric acid, - - - - -	103 "
Ammonia, - - - - - -	19½ "
Chlorine, - - - - -	12½ "
Lime, - - - - - - -	35 "
Magnesia, - - - - - -	11 "
	—— 227 lbs.

30. Thence it appears that the quantity of ammonia held in the air varies according to the locality; and, probably, other circumstances.

31. Horsford, in continuing the experiments above referred to, found that at Boston, in the summer, when vegetable and animal decay is most rapid, the quantity of ammonia in the air is at a maximum, and afterwards decreases regularly until the winter season, when it is at a minimum. The following table shows the amount of thirteen different analyses:—

Date.	Ammonia in 1,000,000 parts, by weight of air.
1. July 3, - - - - - - -	42.9995
2. July 9, - - - - - - -	46.1246
3. July 9, - - - - - - -	47.6308
4. September 1 to 20, - - - -	29.7457
5. October 11, - - - - - -	28.2396
6. October 14, - - - - - -	25.7919
7. October 30, - - - - - -	13.9315
8. November 6, - - - - - -	8.0953
9. November 18, 12 and 13, - -	8.0953
10. November 14, 15 and 16, - - -	4.7066
11. November 17 to December 5, - -	6.1328
12. December 20 and 21, - - - -	6.9885
13. December 29, - - - -	1.2171

Annual of Scient. Disc. 1850, *p.* 221.

Liebig *(Agri. Chem.)* observes "that the ammonia contained in rain and snow water possesses an offensive smell of perspiration and animal excrements,—a fact which leaves no doubt respecting its origin." These experiments have been repeated in France, Germany, America, and England with the same results. It is probable that in the neighborhood of large cities, and in densely peopled countries, the air contains a much larger proportion of this valuable alkali, than in the wild and thinly settled districts. Some curious agricultural and pathological phenomena may be explained by these facts; but the subject still requires more extended and minute examination.

32. Henry and Chevallier have detected acetic acid and probably hippuric acid in the atmosphere. Horsford supposes, as the result of his experiments, that the organic effluvia in the air are of acid character.

33. Ozone, also, appears to vary in quantity.

Ozone is believed to be a form of oxygen, and is produced when electric sparks are taken through perfectly dry oxygen. It is formed in the air during thunder storms. Air impregnated with it acts very much as if a trace of chlorine gas were present, which ozone appears to resemble. Little is yet known of it, but it probably has some connection with health and epidemic illness; and is suspected to act on plants by effecting their growth.

34. Vaughan *(Am. Assoc. of Science,)* states that by means of feeble currents of electricity, the amount of carbonic acid which water and moist surfaces continually absorb from the air, is decomposed, and serves to supply the principal part of the humus of the soil.

35. Although, they have not been detected, there can be no doubt that the Sporules *(seeds)* of minute Cryptogamic plants, such as *Mould, Rust, &c.*, are generally floating in the air, ready to take root wherever they find proper conditions. The atmosphere is also full of Animalcules and infusorial forms.

36. Dr. Smith *(Proc. of British Assoc.)* in experiments on

the air of towns, detected sulphuric acid, chlorine, and a substance resembling impure albumen.* In a warm atmosphere the albuminous matter very soon putrifies, and emits disagreeable odors. By oxidation, this substance gives rise to carbonic acid, ammonia, sulphuretted hydrogen, and probably to other gasses.

37. Mulder found free muriatic acid in the rain water of Amsterdam, which he ascribes to the decomposition of the chloride

* This substance, which has been noticed in rain and snow water by several Chemists, has recently been carefully examined by Dr. A. A. Hayes, of Massachusetts. *(Proc. of Am. Assoc. of Science*, 1850, *B. pp.* 207–212.*)* It has been named ***Pyrrhin***. Obtained from carefully filtered solutions, it appears as a brown yellow adhesive substance, having a strong oder of perspired matter, generally containing the remains of animalcula, spores of fungi, and atmospheric dust. After its solution has been freed from ammoniacal salts, the changes following in its fermentation produce ammonia. Dr. Hayes is inclined to attribute to this substance, a powerful influence over vegetation. When fertile soil is undergoing fermentation, the vapors, by condensation, afford a substance much like Pyrrhin; but the state of admixture here renders it more compound than when it is obtained from the atmosphere through the aid of falling rain. To the falling of this substance from the air, Dr. H. attributes the remarkable growth of vegetation observed in New England and other places, when heavy rain succeeds a long continued period of dry weather in summer. "The more fertile a soil, either naturally or as resulting from judicious cultivation, the more the quantity of matter, having the character of a ferment, we always find in our analysis."

The following passage bearing on this subject appears in ***Silliman's Am. Journal of Science and Arts, for September***, 1853, ***page*** 273:—"In continuation of his long researches on the composition of arable soils, M. Verdeil and M. Rissler have recognized in the aqueous extracts of these soils, the constant presence of a substance like sugar; and also a large proportion of mineral substances, little soluble or even insoluble in water. Thus in 100 parts of aqueous extract, they found 49 of organic matter and 54 of inorganic, consisting of sulphate, carbonate, and phosphate of lime, oxyde of iron, alumine, magnesia, all insoluble in water (or scarcely soluble); and as the presence of carbonic acid alone is not sufficient to explain the presence of these substances in the aqueous extract, MM. Verdeil and Rissler have sought for the cause of this solubility, and concluded that it is due to the saccharine ingredients, for only a very little water is required along with this sugar to dissolve large quantities of insoluble salts. They have recognized again the fact that nitrogen which enters into the composition of humus is found in the condition of an ammoniacal salt, and not in that of an organic substance; for they have collected the whole under the form of ammonia in boiling the concentrated extract with milk of lime."

We refer to this not as yet proving anything certain, but as a subject well worthy of more investigation. There are many unexplained phenomena connected with vegetation which may receive elucidation if these facts prove to be correct. The rapid growth and change of color of plants after a thunder storm in summer has long been noticed by the writer, and probably by most persons living in the country.

of magnesium contained in the waters of the lake of Haarlem, by the action of the sun's rays.

38. The quantity of water in the atmosphere varies considerably, at different times and in different places. It is, besides, dependent on the temperature of the air and of the water evaporating from the earth's surface. The proportion of aqueous vapor has been determined by Verver, for the Netherlands. In 1000 volumes of air, he found the minimum 5.8; the maximum 10.18. The average of fifty observations during May, August, and September was 8.47. From an early hour in the morning to 10 o'clock, A. M. it was 7.97—from 10 to 2 o'clock, P. M., 8.58; and from 2 o'clock till the evening, 8.85 *(Mulder.)*

The atmosphere in New England is believed to be much drier than that of Germany. At a meeting of the Boston Natural History Society, 1852, this difference was discussed. In New England the dew point is several degrees lower. Various differences are noticed by foreign artizans in the processes of their different callings, attributable to this dryness of the air. The climate of New England is regarded as more nearly resembling that of the high Alps than that of any other part of Europe. Missouri, on the contrary, appears to have a still wetter atmosphere. At the winter season of the year the air of New England is so nearly anhydrous, *(free from moisture,)* that such articles as raw hides dry in a temperature just below freezing, without being frozen. *(Annual of Scient. Discov.*, 1853.)

39. All these constituents of the atmosphere have an important influence upon the character and luxuriance of vegetation. Of the whole, however, carbonic acid and water are the most important. Carbon, and the elements of water form the principle constituents of vegetables; the quantity of the substances which do not possess this compositon being in a very small proportion.

40. The leaves and other green parts of a plant exposed to

the light, absorb carbonic acid, decompose it, retain the carbon, and emit an equal volume of oxygen.

Plants thus improve the air by the removal of carbonic acid and by by the renewal of oxygen, which is immediately applied to the use of man and animals. The horizontal currents of the atmosphere bring with them as much as they carry away, and the interchange of air between the upper and lower strata, which their difference of temperature causes, is extremely trifling when compared with the horizontal movements of the winds. Thus vegetable culture heightens the healthy state of a country ; and a previously healthy country would be rendered quite uninhabitable by the cessation of all cultivation.

47. But in the dark, or during the night, the reverse action takes place. Then green plants emit carbonic acid and absorb oxygen; while the whole volume of air undergoes diminution at the same time. From the latter fact it follows that the quantity of the oxygen gas absorbed is greater than the volume of carbonic acid seperated; for if this were not the case no diminution could occur.

42. Liebig has endeavored to prove that plants absorb directly from the atmosphere much of the nitrogen *(ammonia,)* which they require in their composition; but his views are now generally considered unsound; and the ablest physiologists teach that plants in a normal state imbibe carbonic acid and water only through the leaves, while all other constituents enter by the roots through the soil. Mulder lays down the following principle as sufficiently established:—*It is the function of the roots to convey to plants water, ammonia, organic salts, and a small quantity of inorganic salts; but that of the green parts, especially of the leaves, to increase the amount of the non-nitrogenous constituents of plants, by the absorption of carbonic acid, accompanied with an emission of oxygen.*

43. The other components of the atmosphere must, therefore, reach the plant through the soil; they being *generally* imparted to the soil by rain or snow. Their value and importance

will be better understood when we come to speak of the SOIL, of DRAINING, and of MANURES.

44. WATER consists of two *volumes* of hydrogen gas with one volume of oxygen, *chemically* combined: or by *weight*:—

Oxygen, - - - -	88.91	8
Hydrogen, - - - -	11.09	1
	100.00	9

The oxygen and hydrogen are therefore combined exactly in the proportion 8 to 1, as appears by the proportion of the last column. (*Graham.*)

45. From the chemical combination of hydrogen and oxygen in water, a series of special consequences follows in the organic kingdom. It is a known fact that, when substances, chemically combined, are again decomposed, the action of other substances also, which are contained in the circle of action is reciprocally awakened. Wherever in the organic kingdom, water is decomposed—and this frequently happens—the decomposition re-acts on the substance from which the influence proceeded, and produces important chemical transformations of all the substances included in the circle of action. This chemical action proceeds, as regards water, from two elements, which are both chief constituents of organic bodies. (*Mulder.*)

46. *(a.)* The first effect of water on plants is that they are moistened by it. It acts chemically, forming hydrates with organic compounds; also, merely as a liquid, to moisten, dissolve, or keep solid substances in suspension.

47. *(b.)* Water is indispensable to keep the fleshy parts soft, to enable them to grow and be fed.

48. *(c.)* ——— also as a dissolving and suspending fluid. For it is only by the circulation of a fluid through the existing parts of an organic whole, that the support and nourishment of the whole organism can be effected; and many of its actions rest entirely upon this process.

49. *(d.)* The action of water differs in plants and animals as

to the way in which it disappears again from the organic substances.

50. Plants receive water from *(a,)* the dew, *(b,)* from rain, *(c,)* from the soil by evaporation; in case of irrigation, and in certain localities, directly *(d,)* from streams or ponds, and *(e,)* from vapor held in suspension in the atmosphere.

51. A cubic inch of water at 62 ° Fahr., Barometer 30 inches, weighs in air 252,458 grains. The imperial gallon has been defined to contain 10 pounds avoirdupois (70,000 grains) of distilled water at that temperature and pressure. Its capacity is, therefore, 277.19 cubic inches. The specific gravity of water at 60 ° Fahr. is 1, being the unit to which the densities of all other liquids and solids are conveniently referred; it is 815 times heavier than air at that temperature.

Water readily combines with or absorbs a great variety of solid or gasous bodies; and it is by means of water that most of the materials of the structure of plants are introduced. Consequently the composition of the water which cultivated plants may receive in any given locality is of great importance to the Farmer.

53. We have already seen (§28–37) that rain, washing the air, receives a variety of substances from the atmosphere which it conveys to the soil and plant; but the amount of these substances varies in different positions. Thus Dr. Madden has calculated that the quantity of rain which falls at Penicuick, in Scotland, in a year, brings down upon each acre of land in that neighborhood more than 600 lbs. weight of common salt, *(Johnston.)* while in countries remote from the sea it is believed that no salt is held in suspension in the atmosphere. And thus, the rain may supply or withhold an important element of vegitation.

54. Rain water is purer than spring, river, or sea water. Dew is believed to be purer than ordinary rain water.

Dew is caused by the cooling of the earth, plants, &c., by *nocturnal radiation.* The appearance of dew always follows, never precedes

the fall in temperature of the bodies on which it is deposited; thence the phenomenon cannot be attributed to anything more than a simple condensation of the watery vapor contained in the air, comparable in all respects to that which takes place upon the surface of a vessel containing a fluid that is colder than the air. The quantity of the moisture dissolved in the atmoaphere is so much the greater as the temperature is higher. In very warm climates the dew is so copious as to assist vegetation essentially, supplying the place of rain during a great part of the year. When the sky is clear and calm during the night, vegetables cool down and very soon show a temperature *inferior* to that of the air which surrounds them. Thus plants are often destroyed by frost in spring. when the thermometer, a few feet above the ground, stands above the freezing point. But clouds, preventing the rapid radiation, also prevent plants cooling to the same point; and on cloudy nights, as also on those preceeding severe rain storms, there is no dew. The Farmers of Peru, South America, whose crops are often destroyed by this nocturnal radiation, have long been in the habit of making artificial clouds by setting fire to a heap of wet straw or dung, and by this means raising a cloud of smoke which destroys the transparency of the atmosphere, from which they have so much to apprehend. Unless the plants and surface of the earth cool *below* the temperature of the air there cannot be dew. (*Boussingault.*)

55. But it is from springs, and the water otherwise contained in the earth that plants cheifly receive their inorganic nourishment. As such water is always rising to the surface, it brings with it whatever substances are held in suspension by it, and deposits them either near the roots of the plants or on the surface, to be washed down again by rain. Thus the great marl beds, which form the bottom of most of the small lakes of the interior of Michigan, are deposits of lime dissolved in springs, and which becomes a carbonate of lime, and therefore insoluble, when exposed to the atmosphere. The great beds of nitrate of potash and soda, *(saltpetre,)* and other salts, found on the surface in various parts of the world, are believed to owe their existence to the same cause. Tables of the analyses of various waters will be here given, by which it will be seen how important an element it is in the production of vegetation:

2

56. Sea Water, *(Schweitzer,)* from the English Channel.

Water, - - - - - -	96,474
Common Salt, - - - - -	2,706
Chloride of Potassium, - - -	76
Chloride of Magnesium, - - -	366
Bromide of Magnesium, - - -	3
Sulphate of Magnesia, - - - -	229
Sulphate of Lime, - - - -	140
Carbonate of Lime, - - - -	3
Iodine, - - - - - -	traces.
Ammonia, - - - - - -	traces.
	100,000

57. Scuylkill Water, *(B. Silliman, Jr.,)* taken from the Fairmount Reservoir, Philadelphia:

	Grains in 1 gallon.
Chloride of Sodium, - - - -	0.1470
Chloride of Magnesium, - - - -	0.0094
Sulphate of Magnesia, - - -	0.0570
Carbonate of Lime, - - - -	1.8720
Carbonate of Magnesia, - - -	0.3510
Silica, - - - - - - - -	0.0800
Carbonate of Soda, - - - - -	1.6436
Organic and other matter, volatile at red heat,	1.2400
	5.5000

Carbonic acid given off by boiling from 1 gallon, 3.879 cubic inches.

The solid, fixed, and insoluble residue of the same water.—

	Grains in 1 gallon.
Solid residue at 212 ° fahr. - - -	5.50
Fixed at a red heat, - - - -	3.69
Insoluble in water, - - - - -	2.145

The Schuylkill water, when settled clear, is water of superior purity.

58. THE WATERS OF THE DEAD SEA, *(Poggendorff,)* procured near the North end, not far from the mouth of the Jordan:

Chloride of Calcium, - - - - -	2.894
Chloride of Magnesium, - - - -	10.534
Chloride of Potassium, - - -	1.398
Chloride of Sodium, - - - -	6.578
Chloride of Aluminum, - - -	0.018
Bromide of Magnesium, - - - -	0.251
Sulphate of Lime, - - - -	0.088
Silica, - - - - - - -	0.003
	21.773

59. Water from the GREAT SALT LAKE, Utah Territory, *(Dr. L. D. Gale.)* The water was perfectly clear, and had the specific gravity of 1.170.

100 parts evaporated to dryness, and heated to 300 ° Fahr., gave solid contents 22.422, and consisted of

Chloride of Sodium, - - - - -	20.196
Sulphate of Soda, - - - -	1.834
Chloride of Magnesium, - - -	0.252
Chloride of Calcium, - - - -	0. trace.

60. WARM SPRING, OF SALT LAKE CITY, *(Dr. L. D. Gale,)* 100 parts of water gave:—

Sulphuretted hydrogen, absorbed in the water,	0.037454
" " combined with basis,	0.000728
Carbonate of Lime, precipated by boiling	0.075000
Carbonate of Magnesia, " "	0.022770
Chloride of Calcium, - - - - -	0.005700
Sulphate of Soda, - - - - - -	0.064835
Chloride of Sodium, - - - - -	0.816600
	1.023087

61. THE ARTESIAN WELL, AT GRENALLE, near Paris, (*Payen,*) contains in 100,000 parts:—

Carbonate of Lime, - - - -	6.80
Carbonate of Magnesia, - - - -	1.42
Bicarbonate of Potash, - - - -	2.96
Sulphate of Potash, - - - -	1.20
Chloride of Potassium, - - - -	1.09
Silica, - - - - - - -	0.57
Yellow matter, not defined, - - -	0.02
Organic nitrogenous matter, - - -	0.24
	14.30

62. SEVERAL SPRINGS AT HARTFORD, Connecticut, (*Bull,*) give in 10,000 parts of water:—

	I.	II.	III.	IV.	V.
Sulphate of Lime, -	0.69	0.61	0.30	0.79	0.89
Chloride of Magnesium,	0.41	0.23	0.22	0.81	0.41
Chloride of Calcium, -	1.12	0.70	0.39		1 79
Chloride of Sodium, -	1.91				2.67
Carbonate of Lime, -	2.25	1.31	0.21	1.48	
Carbonate of Magnesia,	0.19				1.51
Crenate of Magnesia, -		0.13	0.76	0.44	
Carbonate of Soda, -	0.22	1.09	1.19	2.35	2.67
Oxide of Iron, - - } Alumina, - - - }	0.04	0.38	0.14	0.04	trace.
Lime, - - - -				0.23	
Silica, - - -	0.18	0.60	0.14	0.04	0.10
Loss, - - - -	0.10	0.46		0.18	1.78
Total fixed ingredients,	7.11	5.51	3.35	6.36	11.82

63. These examples are sufficient to show how water in the earth is charged with foreign matter, varying constantly, according to circumstances. The absolute quantity of saline matter contained in spring water, has been shown by Grange to be influenced in some cases, (as in the valley of the Isere,) by the relative height of the locality, and increases from the tops of the mountains towards the valleys. The relative quantities

of the different salts is variable; the soluble salts, particularly the chlorides, were found in this instance to diminish; while the insoluble, or difficultly soluble salts, gypsum and carbonate of lime increased as the site of the spring was at a lower level. The nature of the soil, likewise, alters the relative quantities of the different salts. The chlorides preponderate in magnesian soils, and vary from 25 to 32 per cent., while in anthracitic soil they do not amount to more than 10 or 16 per cent., and in calcareous soil to only between 4 and 8 per cent. of the saline matter. The sulphates are found in nearly the same proportions in calcareous and anthracitic soils; in the former, they vary from 24 to 31, and in the latter from 18 to 37 per cent. In the Nicomien, they do not amount to more than 5 or 12 per cent. of the dissolved saline matter. The carbonates vary from 36 to 47 per cent. in granitic soils; from 48 to 71 in anthracitic, and from 83 to 88 per cent. in chalk soils. Soda salts, (chlorides and sulphates,) preponderate in magnesian, and particularly in anthracitic soils; the total quantity of sulphates in the latter soils is much greater. Magnesian salts are remarkably constant in water from magnesian and anthracitic soils; their relative quantity averages between 19 and 23 per cent. in water from granitic salts and slates; and between 11 and 23 in anthracitic formations.—*(Knapp.)*

64. The quantity of saline and earthy matter in spring water, varies from about 20 grains to 1,800 grains in the gallon; when above 100 grains per gallon, it constitutes a mineral water. The average quantity in ordinary spring water is from 20 to 80 grains. The most common salts are sulphate and carbonate of lime, sulphate, muriate, and carbonate of potash and soda.

65. The presence of phosphoric acid in some waters has recently been discovered.

66. Three-fourths of the weight of the body of man and of the higher animals is composed of water; and the lower animals are constituted in like manner. Even the wood of trees

contains one-third and more of its weight of water. Dr. Salisbury gives the following tables exhibiting the per centage of water, dry matter, and ash in the horse chestnut, *(Æsculus hippocastanum,)* at Albany, N. Y., at two different periods:

MAY 4, 1849.

	Imbricated scales of buds coated with wax.	Leaf Blades	Young twigs and petioles 2 to 3 inches long.	Bark from limbs 2 inches in diameter.	Wood from limbs 2 inches in diameter
Per cent. of water, -	80.000	79.408	88.987	51.000	56.130
Per cent. dry matter, -	20.000	20.592	11.013	49.000	43.870
Per cent. ash, - -	1.852	1.838	1.271	5.000	0.510
Per cent. ash, cal. on dry matter, - -	9.359	8.927	12.479	10.204	1.162

MAY 18, 1849.

	Peduncles.	Leaf blades.	Young twigs and petioles.	Bark from limbs 2 inches in diameter.	Wood from limbs 2 inches in diameter.
Per cent. of water, -	87.047	78.485	84.730	50.500	48.000
Per cent. dry matter, -	12.953	20.515	15.270	46.500	51.970
Per cent. ash, - -	1.313	1.582	1.100	4.290	0.550
Per cent. ash, cal. on dry matter,	10.133	7.746	7.209	9.226	1.116

67. The air in water is a mixture of the same constituents as atmospheric air, but they are not present in the same proportions—the air contained in water being much richer in oxygen, and containing 32 per cent. of its volume of that element *(Knapp,)* and in water from freshly melted snow 34.8 per cent. The quantity of air retained by water at an altitude of 6 to 8000 feet is reduced to one-third of its usual proportion. Hence fishes cannot live in Alpine lakes.

63. Water contained in the soil may be so impregnated with salts or organic acids as to destroy vegetation. Some of the salts of iron are thus destructive. A cure may be effected by thorough draining. Water containing the salts of lime is called *Hard Water*. Its effect on horses is very remarkable. Hard

water drawn fresh from the well will make the coat of a horse unaccustomed to it *stare:* and it will not unfrequently gripe and otherwise injure him. *(Youatt.)* Milk, butter, and cheese are also sensibly affected by the quality of the water drunk by the cow. Dr. Wilson has found fluoride of calcium in milk, as well as in the blood and urine of animals, which must have been derived from this substance dissolved in the water usually drunk. *(Proc. British Assoc.)*

69. Goitre and Cretinism, diseases common in the vallies of the Alps, as well as in the other parts of the world, are believed to arise from the deleterious action of the water containing salts of magnesia, and the absence of a sufficient quantity of lime. In some places cattle are subject to a disease of the bones in consequence of a want of lime in the water. On the contrary, carbonic acid acts favorably on vegetable life. Dr. Daubeny found by experiments, that although very large quantities of carbonic acid were injurious to plants, yet that when present in water, from one to five per cent. more than is natural, it is beneficial.

70. M. Lassaigne has found arsenic present in the natural deposites of the mineral waters of Wattviller to the amount of 2.8 per cent.; but the poisonous property of the arsenic is destroyed by its combination with peroxide of iron. Free sulphuric acid has also been detected in springs in Virginia.

71. River water differs much in its constituents from spring water. It takes its character from the geological formations through which it flows. It is apt to hold in suspension much sand, earth, and organic matter. The quantity of sediment discharged by the Mississippi River annually is estimated at from 2,137,061,974 cubic feet *(Marr)* to 28,188,083,892 cubic feet *(Brown and Dickeson.)*

CHAPTER III.

THE SOIL.

72. To a common observer the soil is a heavy, cohesive, torpid substance; varying in color; and, more or less, mixed with stones. Examined scientifically, it is a compound substance; made up of many materials, each of them differing in its qualities; some of them lying in mere mechanical contact; others chemically combined. The soil is usually divided into two parts, *(a,)* the surface soil; *(b,)* the sub-soil. They usually differ *(c,)* in constitution; *(d,)* mechanical structure; and *(e,)* by the first *(a,)* containing more organic matter, and less salts than the other.

73. Strictly all accumulations of loose materials resting upon rock constitutes the soil. These loose materials vary in depth from a few inches to one or two hundred feet; and occasionally consist of different layers or beds placed one over the other.

74. The earthy matter of all soils has been produced by the gradual decay, degradation, or crumbling down of previously existing rocks.

75. Soils are formed *(a,)* immediately from the rock upon which they rest; or *(b,)* from deposites, drift, &c., brought by water and other geological causes from a distance. In the latter case, the soil may have no relation whatever, either in mineralogical characters or in chemical constitution, to the immediately subjacent rocks. To these constituents must be added the remains of plants and animals; and carbon.

76. The principal rocks whose decay has given rise to the formation of soil may be briefly enumerated as follows: (*Mulder.*)

(*a*,) Quartz Rocks; (*b*,) Feldspar Rocks; (*c*,) Mica Rocks; (*d*,) Hornblende Rocks; (*e*,) Serpentine Rocks; (*f*,) Augite Rocks; (*g*,) Alumina Rocks; (*h*,) Lime Rocks; (*i*,) Gypsum; (*j*,) Iron.

77. The value of Irrigation for the purpose of manure depends upon the geological formation through which the stream passes.

79. Soils differ much in the relative quality of the substances which compose them; but all *fertile* soils contain the same materials.

80. The great bulk of all such soils consists of three earths: (*a*,) Silica, (or sand,) (*b*,) Alumina, (or clay,) (*c*,) Lime. Generally, these lie in juxtaposition, inert, and producing no effect on each other. To these must be added (*d*,) Water, which is always present uniting them. Deprived of water, soil becomes dust; but the water varies in its relative quantity according to the proportionate mixture of these three materials.

81. The economical character and usefulness of the soil varies in proportion to the predominance of one or other of these substances.

82. On a general average, the earthy part of the soil constitutes about 96 per cent. of its whole weight when free from water. (*Johnston.*)

83. By *Silica*, is meant siliceous sand or siliceous gravel of various degrees of fineness from an impalpable powder to sand-stones. By *Clay*—a finely divided *chemical* compound consisting very nearly of 60 per cent. of Silica and 40 per cent. of Alumina, with a little oxide of iron, and from which no sandy matter can be separated mechanically or by decantation. By *Lime*—Carbonate of Lime, in the shape of chalk, limestones, marl, shell-sand, &c.

84. Soils may be classified as follows:—

(*a*,) Pure Clay, *pipe clay*, = 60 per cent. Silica, 40 per cent. Alumina, oxide of iron chemically combined. (*b*,) Strongest clay soil, *brick clay*, pure clay (*a*,) with 5 to 10 per cent. of sand which can be separated by boiling and decantation. (*c*,) Clay loam = 15 to 30 per cent. fine sand and pure clay.

(d,) Loamy clay = 30 to 60 per cent. sand and pure clay. *(e,)* Sandy loam = 60 to 90 per cent. sand and pure clay. *(f,)* Sandy soil contains no more than 10 per cent. of pure clay. *(g,)* Marley soils, in which the proportion of lime is more than 5, but does not exceed 20 per cent. of the whole weight of the dry soil. *(h,)* Calcareous soils, in which the lime exceeding 20 per cent. becomes the distinguishing constituent. *(i,)* Vegetable soils—of various kinds, from garden mould which contains from 5 to 10 per cent., to the peaty soil in which the organic matter may amount to 60 or 70 per cent. These soils are also clayey, loamy, or sandy, according to the predominant character of the earthy admixtures.

85. The only use of the great bulk of the soil appears to be *(a,)* the upholding of the plant, and giving it a firm basis from which to spring; *(b,)* the absorption of gasses, and the imbibing and retaining of other elements; *(c,)* the supplying of water.

86. The remaining constituents of the soil may be divided into *(a,) Organic matter; (b,)* and chemical substances and salts, or *Inorganic matter.*

87. All soils contain organic matter in a greater or less proportion. This organic matter consists, in part, of decayed animal, but chiefly of decayed vegetable substances; sometimes in brown or black fibrous portions; sometimes forming only a fine brown powder intimately intermixed with the mineral matters of the soil; sometimes scarcely perceptible in either of these forms; and existing only in a state of organic compounds more or less devoid of color; and at times entirely soluble in water. In soils which appear to consist only of pure sand or clay, organic matter in this latter form may often be detected in considerable quantities.'

88. Chemically the organic compounds of the soil are thus termed :—(*a*,) Crenic acid ; (*b*,) Apocrenic acid ; (*c*,) Geic acid ; (*d*,) Humic acid ; (*e*,) humin, (or humus) ; (*f*,) Ulmic acid ; (*g*,) Ulmin. Humin

and ulmin are insoluble in alkalies and in water; the others are readily soluble in alkalies, and more or less in water also.

89. All organic matter may be resolved into the four gasses, carbon, oxygen, hydrogen, and nitrogen; with or without a little *ash*, or inorganic matter.

90. The nature and quantity of organic matter in the soil have great influence upon its character and fertility.

91. The most useful portions of plants are chiefly organic; as the woody fibre, starch, gum, sugar, gluten, and albumen; and in animals, the flesh, milk, butter, cheese, &c. Barn-yard manures, are also chiefly composed of water and organic matter. Thus, in well-preserved manure is found (*Richardson,*) in 100 parts:—

Water, - - - - - -	65 parts.
Organic matter, - - - -	24½ "
Inorganic salts, - - - - -	10 "

92. The inorganic matter forms the smallest portion of the soil, but it is absolutely essential for the production of useful vegetation. Without it plants will not produce seed; and the deficiency of a single element may render the soil entirely barren.

93. The names of these inorganic elements are:—

Name.	In combination with	Forming
Chlorine, (*Bleaching Gas,*)	Metals,	Chlorides.
Iodine, - - -	"	Iodides.
Sulphur, - - -	"	Sulphurets.
" - - -	Hydrogen,	Sulphuretted Hydrogen.
" - - -	Oxygen,	Sulphuric acid.
Phosphorus, - - -	"	Phosphoric acid.
Potassium, - -	"	Potash.
" - - -	Chlorine,	Chloride of Potassium.
Sodium, - - -	Oxygen,	Soda.
" - - -	Chlorine,	Common Salt.
Calcium, - - -	"	Chloride of Lime.

Calcium, - - -	Oxygen,	Lime.
Magnesium, - -	"	Magnesia.
Aluminum, - - -	"	Alumina, *(Clay.)*
Silicon, - - -	"	Silica, *(Sand.)*
Iron and Manganese, - -	"	Oxides.
	Sulphur,	Sulphurets.

94. With the exception of Iodine, the above appear to be essential to the composition of all cultivated plants.

95. The organic and inorganic elements are chemically combined, and are always undergoing change. They perhaps never exist in plants in a simple form.

96. These inorganic materials may be so carried away from the soil by injudicious cropping that at last the land refuses to bear grain, until they are replaced, or, in other words, till the land is manured. Again, manure, by its chemical action, may set free these elements in the soil which were previously unfit for absorption by roots. To recapitulate

97. A fertile soil consists of three earths:—*(a,)* Sand; *(b,)* Clay, and *(c,)* Lime, mechanically combined; *(d,)* of four gasses, forming organic matter; and *(e,)* of eleven or twelve inorganic elements, in small quantities, chemically combined.

98. Practically, the difference between a rich and an impoverished soil is this:—A rich soil contains every thing a plant requires *in a soluble state*, ready to be at once absorbed by the roots of the plant. A worn-out soil contains the same constituents but *in an insoluble state*, not capable of being dissolved in water, and therefore unable to enter into the roots.

99. On whatever soil a plant is grown, if it shoots up in a healthy manner, and fairly ripens its seed, the quantity and quality of the ash is nearly the same.

100. No two plants of a different order contain the same quantity and quality of inorganic matter. The more widely two plants differ in their natural character, (*e. g.* turnips and wheat,) the wider will be the difference between their constituents.

101. On these principles, in practical farming, is based the utility of fallowing, and the rotation of crops.

102. The *mechanical texture* of the soil has a strong influence upon its practical fertility; very heavy clays, and very light sands, being both, for opposite reasons, apt to produce badly. The soil in which the particles are the finest, so that the air can enter, and the roots spread without difficulty, is, other things being equal, the best. In clay soils this division of the particles must be produced by the plow and other mechanical means; while in loose sands it is too great, and must be amended by an admixture of clay and other substances. The great fertility of the bottom lands of the Scioto River, Ohio, is attributed to the remarkable comminution of the particles of these soils.

103. The sub-soil also produces a sensible effect on the condition of the soil above it. If the soil is clay, it is impervious to water, and if the sub-soil is clay also, it also is impervious to water. The immediate effect of this arrangement is to render both soil and sub-soil habitually wet, and therefore cold, or perhaps barren, until evaporation dries first the one and then the other. A retentive sub-soil may render even a porous, sandy or gravelly soil above it habitually wet. A gravelly sub-soil, which is always porous, greatly assists in keeping a clay soil dry. When a porous soil rests on a sandy sub-soil, water can do no injury, while in dry weather, the evaporation from below may do great good. On the other hand, a clay sub-soil retains manure, while a sandy one allows it to leach away, and in practice, renders the soil incapable of improvement. Rock may act either as a retentive or porous sub-soil, according to its structure. In many clay sub-soils, draining is absolutely necessary. In sandy and gravelly sub-soils, very rarely so.

103*. There is an important element which must always be taken into account in estimating the value of soils—*their depth or thickness*. In running a deepish furrow in a cultivated field, we generally distinguish, at a glance, the depth of the super-

ficial layer, which is commonly called the *mould* or *vegetable earth;* this is a layer generally impregnated with humus, and is looser and more friable than the sub-soil upon which it rests. The thickness of this superficial layer is extremely variable; varying from two inches to two feet. Depth of mould or vegetable soil is always, practically, advantageous; it is one of the best conditions to successful agriculture. If we have depth of soil, and the roots of our plants do not penetrate sufficiently to derive benefit from the fertility that lies below, we can always, by working a little deeper, bring up the inferior layers to the surface, and so make them concur in fertilizing the soil. Farther, a deep soil suffers less from excess or deficiency of moisture; the rain that falls has more to moisten, and is therefore absorbed in greater quantity than by thin soils; and, once imbibed, it remains in store against drought.

104. Soils also vary much in color, as *(a,)* black; *(b,)* white; *(c,)* blue; *(d,)* red; *(e,)* brown. The colors of soil have a considerable influence in regulating the quantities of heat absorbed from the sun's rays; the darker colored absorb more heat than the lighter colored; and the dark colored reflect the least.

105. According to Shubler, while the thermometer was 77° in the shade in August, sand of a natural color indicated a temperature of 112½°; black sand, 123½°; and white sand, 110°, exhibiting a difference of 13° in favor of the black color.

106. Color also influences the power of soil in retaining the heat of the sun. Dark colored soils, in the absence of the sun's rays, radiate or part with the heat more quickly than light colored. Thus sand cools more slowly than clay, and clay than a soil containing much vegetable matter. This principle has a strong practical influence on the deposit of dew, and injury to vegetation by night frosts.

107. Soils also vary in their power of absorbing and retaining moisture. The absorption is greatest in clay soils, especially when they contain humus, (vegetable matter.)

Schubler gives the following table of the relative absorbing power of soils :

KINDS OF EARTH.	1,000 grains of earth on a surface of 50 square inches, absorbed in			
	12 hours.	24 hours.	48 hours	72 hours.
	Grains.	Grains.	Grains.	Grains.
Siliceous sand, - -	0 water.	0 water.	0 water	0 water
Sandy clay, - -	21 "	26 "	28 "	28 "
Loamy clay, - -	25 "	30 "	34 "	32 "
Brick clay, - -	30 "	36 "	40 "	41 "
Gray pure clay, - -	37 "	42 "	48 "	49 "
Garden mould, - -	35 "	45 "	50 "	52 "
Arable soil, - -	16 "	22 "	23 "	23 "
Humus, - -	80 "	97 "	110 "	120 "

Thus, while sandy lands may suffer from long continuance of dry weather, a neighboring field abounding in humus may absorb sufficient moisture from the air to serve all the requirements of vegetation.

108. The power of saturation by water, and the retention of moisture, vary in the same manner, and nearly in the same degrees.

109. Another important physical property of soils, is their power to absorb oxygen from the air.

According to Schubler :—

Grains.	Cubic inches.
1,000 Siliceous sand, in a wet state, absorbed oxygen,	0.24
1,000 Sandy clay, - - - - -	1.39
1,000 Loamy clay, - - - - -	1.65
1,000 Brick clay, - - - - -	2.04
1,000 Gray pure clay, - - - - -	2.29
1,000 Garden mould, - - - - -	2.60
1,000 Arable soil, - - - - -	2.43
1,000 Humus, - - - - -	3.04

From 15 cubic inches of atmospheric air, containing 21 per cent. of oxygen.

Soils lose, in drying, the property of absorbing oxygen from the air, but regain it in the same proportion as before, on being moistened. The action of organic manures, and the production of carbonic acid, depend on the existence of oxygen in the soil; and, in practice, the difference is very great. Every farmer knows how little good is effected by his barn-yard manure on a crop in a very dry season, compared with a moderately wet one.

And, in the same manner, such manures act more rapidly in soils rich in humus than in those chiefly consisting of sand.

110. The different classes of soils are distinguished by growing different classes of weeds; and frequently by the existence of different noxious insects.

111. The capillary power of soils also differs.

Capillary attraction or power, means the power by which a liquid ascends in the interior of a capillary tube, or tube of small bore, above the surface of the liquid which surrounds it. The phenomenon occurs in solid bodies which are capable of being wetted. Thus, when water is poured into the basin of a flower-pot, the soil gradually sucks it in, and becomes moist even to the surface. The same takes place in the soil in the open fields. The water from beneath—that contained in the subsoil—is gradually sucked up to the surface. Where water is present in excess, this capillary action keeps the soil always moist and cold.

Evaporation takes place from the surface of the land, and as each atom of moisture is taken up into the atmosphere, its place is supplied by another atom, communicated by the contact of the particles of soil, the more superficial acting on the deeper particles like so many pumps, to elevate the water, and supply the loss. Thus a naturally porous soil may be kept injuriously wet by an impervious sub-soil several feet below.

Ordinary soils possess the power of separating, from solution in water, the different earthy and alkaline substances presented to them in manure. But these substances, necessary for the growth of the plant, are rapidly carried, by rain and other causes, down into the sub-soil, beyond the reach of roots. Were there no counteracting influences, these substances would soon be lost, and all soils become barren. But when warm weather comes, and the surface soil dries rapidly, then by capillary action the water rises from beneath, bringing with it the soluble substances that exist in the sub-soil, through which it ascends. And as this ascent and evaporation go on as long as the dry weather continues, the saline matter accumulates about the roots of the

plants, so as put within their reach an ample supply of every soluble substance which is not really defective in the soil. Practically, this principle is of great importance in manuring and draining.

The relative capillary power of soils has not yet been thoroughly tested; but, generally, in sandy and light soils, of which the particles are very fine, this capillary action is of great importance, and is intimately connected with the power of producing remunerating crops.

112. The following analyses are given as examples of various classes of Soils:—

I. CLAY:—Three specimens from the Zuider Zee, in the Netherlands (*E. H. von Baumhauer.*)

	First.	Second.	Third.
Insoluble quartzose sand, with alumina and silica,	57.646	51.706	55.372
Soluble silica,	2.340	2.496	2.286
Alumina,	1.830	2.900	2.888
Peroxide of iron,	9.038	10.305	11.864
Protoxide of iron,	0.350	0.563	0.200
Protoxide of manganese,	0.288	0.354	0.284
Lime,	4.092	5.096	2.480
Magnesia,	0.130	0.140	0.128
Potash,	1.026	1.430	1.521
Soda,	1.972	2.069	1.937
Ammonia,	0.060	0.078	0.075
Phosphoric acid,	0.466	0.324	0.478
Sulphuric acid,	0.896	1.104	0.576
Carbonic acid,	6.085	6.940	4.775
Chlorine,	1.240	1.302	1.418
Humic acid,	2.798	3.991	3.428
Crenic acid,	0.771	0.731	0.037
Apocrenic acid,	0.107	0.160	0.152
Humin, vegetable remains, and water chemically combined,	8.324	7.700	9.340
Wax and resin,	trace	trace	trace
Loss,	0.542	0.611	0.753
	100.000	100.000	100.000

These are very rich soils, and derive their origin from the Rhine country, and are the product of decayed rocks.

113. II. Cotton Lands of Mississippi. (*J. P. Norton.*)

		A.	B.
	Organic matter,	4.740	6.290
Soluble in Water. A. 2.470 pr ct. B. 0.147 "	Silica,	1.299	0.072
	Iron, alumina, and phosphates,	0.230	0.019
	Lime,	0.389	0.020
	Magnesia,	0.090	none
	Manganese,	0.034	none
	Potash,	0.248	0.120
	Chloride of sodium, (common salt,)	0.107	....
	Soda,	....	0.015
	Sulphuric acid,	0.144	0.009
Soluble in Acid. A 4.96 pr ct. B. 5.19 "	Silica,	0.409	0.920
	Alumina,	1.644	1.820
	Iron,	1.448	0.670
	Lime,	0.535	1.340
	Magnesia,	0.576	0.080
	Manganese,	0.002	none
	Potash,	0.348	0.070
	Soda,	....	0.180
	Sulphuric acid,	0.070	0.080
	Phosphoric acid,	0.042	0.003
Insoluble Portion. A. 87.83 pr ct. B 88.373 "	Silica,	78.845	84.930
	Iron and alumina,	5.946	2.370
	Lime,	1.098	0.260
	Magnesia,	1.142	0.680
	Manganese,	0.623	none
		100.059	89.867

A. is from a strong cotton soil. B. was originally the same soil, but has been worn out by long cultivation. This analysis is peculiarly valuable as an illustration. The first table gives the organic elements soluble in water, and which alone are available for the growth of the plant. In the new soil this amounts to about 2½ per cent. of the whole. In the worn out soil, it is very trifling. A plant grown in the latter would be nearly starved; while it would be entirely deficient in two elements of nutrition. The second table gives the inorganic elements soluble in acid, but not in water. While, therefore, these are not

available for a growing crop, yet by means of rest, by the action of carbonic acid, and of the atmosphere, or by *fallowing*, and by the application of *chemical* or dissolving manures, they may, to a certain extent, be rendered soluble in water, and the producing power of the soil be restored. Thus, shut up, there are materials enough to grow twice the amount of crops already taken from the land. The third table gives the inorganic constituents, which are not soluble by any available means; and therefore they must be considered only as the basis for the others.

Another fact to be observed is the very small proportion of such constituents available at any one time for the growth of plants; and the facility with which soils may be impoverished. In each 100 lbs. of the soil, free from moisture, only about 2 lbs. can be converted into vegetation.

This table will be again referred when we come to consider the subject of manures: but it is necessary to remark that, in actual growth, a plant *may* receive more than the above of necessary nutrition by means of water evaporating from below. (§111.)

114. III. Fertile pasture soil (A). Fertile arable soil (B). Barren or unfruitful soil (C). (*Johnston.*)

	A.	B.	C.
Silica, Quartz, Sand, and Silicates, -	71.849	87.143	61.576
Alumina, - - -	9.350	5.666	0.450
Oxides of iron, - - -	5.410	2.220	0.524
Oxide of Manganese, - -	0.925	0.360	trace
Lime, - - - -	0.987	0.564	0.320
Magnesia, - - -	0.245	0.312	0.130
Potash and Soda, - - -	0.007	0.145	trace
Phosphoric acid, - - - -	0.131	0.060	"
Sulphuric acid, - - -	0.174	0.027	"
Chlorine, - - -	0.002	0.036	"
Humic acid, - - - -	1.270	1.304	11.470
Insoluble humus, - -	7.550	1.072	26.530
Organic matter, containing nitrogen,	2.000	1.011	....
Water, - - - -	0.100	....	....
Carbonic acid united to the lime, -	....	0.080	trace

The first is from a fertile alluvial district of Hanover, from the banks of the Weser; the second, from the banks of the Ohio River, is celebrated for yielding successive crops of corn for a long period without manure; and the third is from a moor in East Freisland.

115. IV. The following (A,) is from an analysis of an inferior wheat soil, at Three Rivers, Michigan, by *Dr. S. H. Douglass*, compared with a good and fertile soil (B,) analyzed by *Prof. Norton.*

1000 parts gave *soluble* in water	A.	B.
Humic acid and ammonia,	0.264	4.740
Silica,	0.063	1.299
Lime,	0.256	0.389
Potash and Soda,	0.243	0.445
Iron, alumina, and phosphates,	0.120	....
1000 parts gave *insoluble* in water		
Silica,	902.	788.45
Lime,	1.7	10.98
Iron, alumina, and phosphates,	34.	59.46
Humic acid,	4.7	....
Potash and Soda,	2.04	....
Organic matter,	54.	....
Not ascertained,	,654	....

116. V. Analysis of an impoverished soil in the town of Freehold, Monmouth County, New Jersey, (A,) with the constituents which it ought to contain to render it productive, (B.) (*Dr. Antisell.*)

	A.	B.
Organic matters,	4.50	9.70
Silicates,	87.60	....
Alumina,	3.65	5.70
Lime,	0.45	5.90
Magnesia,	trace	....
Per-oxide of iron,	1.39	....
Potash,	0.01	0.20
Soda,	0.08	0.40
Chlorine,	0.06	0.20
Sulphuric acid,	0.12	0.20
Phosphoric acid, with iron as phosphate,	0.03	0.40
Carbonic acid,	....	4.00
Moisture,	2.00	....
Loss,	0.01	....
	100.00	

117. VI. Marl from Bordentown, (A,) and from Squankum, (B,) New Jersey. (*Dr. Antisell.*)

	A.	B.
Silicates, insoluble in hydrocholoric acid,	68.66	76.00
Alumina,	7.00	5.00
Lime,	1.40	2.85
Magnesia,	0.38	0.18
Peroxide of iron,	9.00	3.20
Potash,	3.70	5.80
Soda,	0.30	1.10
Chlorine,	0.20	0.40
Sulphuric acid.	1.30	0.90
Phosphoric acid,	0.28	0.46
Carbonic acid,	....	1.84
Moisture,	6.46	2.00
Sulphur, combined with iron,	1.32	0.27
	100.00	100.00

118. VII. Green Sand Marl, Shrewsbury, Monmouth county, New Jersey; two varieties. (*H. Wurtz.*)

	A.	B.
Silica,	48.24	47.83
Alumina and oxide of iron,	32.89	34.98
Potash,	6.38	4.94
Magnesia,	2.60	....
Hygroscopic water,	4.81	11.50
Combined water,	5.69	
	100.61	99.25

119. VIII. Red Marl, Springfield, Mass. (*Dr. C. T. Jackson.*)

Water,	8.5
Silex,	51.3
Alumina,	16.0
Peroxide of iron, with a trace of manganese,	20.0
Lime,	2.8
Magnesia,	1.0
	99.6

120. IX. Analyses of Shell Marl, Forfarshire, (A,) and Clay Marl, Ayrshire, (B,) Scotland, (*Johnston.*)

	A.	B.
Carbonate of lime, - - - -	81.7	8.4
Oxide of iron and alumina, - - - - -	0.6	2.2
Organic matter, - - - - - -	14.6	2.8
Clay and silicious matter, - - - - -	3.1	84.9
Water, - - - - - -	.....	1.4
	100 0	99.7

CHAPTER IV.

METEOROLOGY.

121. A good soil, well worked, with good seed, is not the only element of success in farming; the CLIMATE has a powerful controlling influence on agricultural pursuits; an influence to which the farmer is compelled to submit. By knowledge, however, he may so adapt his business to the climate, as to render the changes to which it is subject, beneficial, instead of injurious to him.

122. The study of the laws which govern the climate is called *meteorology*.

The word "meteorology" means, literally, the science of meteors; but the term is applied, more extensively, to the investigation of all the physical causes which affect the condition of our globe; and particularly to the effects of light, heat, and winds on the earth, the ocean, and the atmosphere, and the results of these agents in the production of climate.

123. As meteorology is in itself an abstruse science, it will only be necessary, in this place, to give such principal laws and facts as bear upon agriculture.

124. The main elements of climate are, *(a,)* the temperature of the air; *(b,)* of the soil; *(c,)* the quantity of rain and dew that fall; *(d,)* the character of the prevailing winds; *(e,)* the length of the seasons of heat and cold; and *(f,)* the seasons at which, and the mode in which the rains prevail.

125. There is *(a,)* a general climate, and *(b,)* a local climate. The first is equal, over the whole globe, on the same *Iso-thermal*

lines; the second depends on local circumstances, such as mountains, table lands, large forests, lakes, &c., which affect the distribution of heat and rain; and which may render the local climate better or worse than the general one. In the United States, the local climate is found to change as the country is settled and cleared; and it often varies sufficiently, within a comparatively small area, to influence the sort of crops to be grown, and the stock to be kept.

Iso-thermal lines are lines of equal temperature; a term applied to imaginary lines drawn on a map connecting all those places on the surface of the globe which have the same mean temperature. Lines drawn through places having the same summer temperature, are termed *Iso-theral;* those drawn through places having the same winter temperature, are called *Iso-cheimal;* while lines drawn through places having other common temperatures, receive other appropriate names. Fully to explain this to the student, it will be necessary for the teacher to exhibit a physical atlas of the globe, where the various lines are laid down.

126. The climate may be *practically* changed, to a certain extent, by the farmer, by means of cutting down forests, draining, deep plowing, high walls, and plantations of trees; and by the gardener, to any extent, by means of hot-beds, hot-walls, glass-houses, manures, &c.

127. The following changes take place, owing to the cultivation of a new country: *(a.)* Fogs disappear, and with them agues and other diseases; sometimes naturally; almost always, by a proper and sufficiently extensive system of drainage.* *(Brown & Dickeson, Prof. Johnston.)* *(b.)* Dews are less heavy; the quantity of running water is diminished; lakes and marshes dry up; hail-storms become more frequent; early and late frosts are more injurious to vegetation.—*(Boussingault.)*

128. On the contrary, by neglect, a previously healthy coun-

* A very striking instance of the improvement of health, and the ceasing of miasmatic diseases throughout a whole township, in consequence of draining, in Beverly, Mass., is given in the *Abstract from the Returns of Agricul. Soc. in Mass., for* 1846, *p.* 31.

try may become incapable of sustaining human life, as in the marshes surrounding Rome, Italy; and the waters may again encroach and cover land that was previously retrieved from them, as in the Aragua Valley, Venezuela, So. America.—*(Boussingault.)*

129. The cultivation of perennial plants is limited by the lowest temperature of winter; that of annual plants by the mean temperature of summer. Thus a country so cold as to be incapable of sustaining trees, may yet have a sufficiently long and hot summer to mature grains and vegetables; and annual plants may prosper in a latitude so far North that perennial ones, indigenous to the same climate, would perish from cold.

The heat of the atmosphere is measured by an instrument called a *thermometer*, consisting of quicksilver or alcohol, enclosed in a vacuum tube, with a hollow bulb at one end. This is placed upon a scale, graduated by actual experiment; and the quicksilver rises and falls in the tube, according to the amount of heat. Three different modes of graduation are employed in different countries; *Fahrenheit's* in America and Great Britain; *Centigrade* in France; and *Reaumur's* in France and other parts of Europe.

212 degrees, (°) of Fahrenheit equal 100° Centigrade, and 80° Reaumur.

32 degrees of Fahrenheit equal 0 Centigrade, and 0 Reaumur.

There are various forms of the Thermometer, but all on the same principle.

By the term *mean temperature*, is meant the temperature obtained by adding together the temperatures of the days or months required, and dividing by the number of days or months. *Mean annual temperature* is obtained by adding together the temperatures of all the months of the year, and dividing the sum by the number of the months; so that the *mean annual temperature* expresses the height at which the thermometer would stand at any place, if we could suppose it perfectly stationary throughout the year.

130. For the cultivation of annual plants, it is only necessary to know the mean temperature of the climate during the number of months requisite for growth and the maturation of the seed.

Boussingault gives the following list of temperatures favorable to the particular plants, in the success of which man is more especially interested. Some of them require a mean *annual* temperature, others only a mean *summer* temperature, as below:

NAME.	Maximum.	Minimum.	NAME.	Maximum.	Minimum.
Chocolate Bean,	82° F.	73°	Rice,	82°	75°
Banana,	"	64	Pine Apple,	"	68
Indigo,	"	71	Melon,	"	67
Sugar Cane,	"	71	Coffee,	79	74
Cocoa Nut,	"	78	Wheat,	74	44
Palm,	"	78	Barley,	"	59
Tobacco,	"	65	Potatoes,	75	52
Maize,	"	59	Flax,	74	54
French Beans, (Haricots,	"	59	Apple,	72	59
			Oak,	67	61

Thus we can grow melons, which only require a short period of summer for growth and maturation; but cannot grow pine-apples, which require at least two years before they bear fruit; although the former only needs one degree of mean temperature less than the latter.

131. The number of days that elapse between the commencement of vegetation and the period of ripeness is by so much the greater as the mean temperature is lower. Thus, wheat, with a mean temperature of 59° F., requires 137 days to mature; with a temperature of 56°, 160 days; with a temperature of 76°, 92 days. In other words, the lower the mean temperature of the climate, the longer the crop must be in the ground before harvesting. And thus Indian corn may ripen in a sheltered valley, but be annually cut off by frost on a mountain side a few miles distant.

Experiments, however, prove that many grains, brought from a climate with a markedly lower mean summer temperature, to one higher, only acquire the power of ripening early *by degrees of successive annual crops,*

a fact which is practically important in the growth and quality of certain grains.

Upon every parallel of latitude, at all elevations above the level of the sea, the same plant receives in the course of its existance an equal quantity of heat.

132. The temperature of the soil, in summer, greatly exceeds that of the air. At Albany, N. Y., the temperature of the soil rises to 100° F. five feet below the surface, and to 140° half an inch below. *(Johnston.)* But this temperature varies according to the color and quality of the soil, the evaporation, the amount of water it contains, the nature of the subsoil, &c. This internal heat is of great importance in practical farming; a warm, dry soil allowing the seeds to sprout early in the spring; forcing forward the plant, as in a hot-bed; regulating the amount of dew deposited; controlling early and late night frosts; and probably influencing, favorably for the farmer, the growth of parasitic fungi, such as *rust, mildew, &c.* It also causes manures to act, and produces other beneficial effects, such as electrical currents. It can be regulated and increased by artificial means, but chiefly by proper drainage.

133. Seeds require a given temperature of air and soil for healthful germination; various plants differing in this respect: some requiring a much higher temperature than others. On this point, the following laws have been laid down: *(a.)* When the temperature at noon is given, (other things being equal,) the time necessary for the development of a seed may be ascertained. *(b,)* If the period of germination be given, the meridian temperature of the country during the period may be determined. *(c,)* When the seed fructifies in the same year in which it is planted, the proper time for putting it into the ground is when the meridian temperature is such as to produce vegetation in the shortest period. *(d,)* An increase of temperature beyond a certain point, does not expedite the vegetative process.

The following table has been drawn up from actual experiment,

(J. T. Plummer;) but it would have been more perfect if the temperature of the soil had also been recorded:

When the average meridian temperature in the shade is	62° F.	Lima Beans, *soaked*, require		20 days.
	76	do	s.	7 "
	88	do	s.	7 "
	51	Peas,	s.	19 "
	59	do	s.	13 "
	74	do	s.	11 "
	80	do		14 "
	60	Bishop's early Peas,		10 "
	62	do do		8 "
	55	Radishes,	s.	12 "
	60	do	s.	7 "
	70	do	s.	3 "
	62	Onion seed,	s.	15 "
	77	do	s.	9 "
	54	Drum-head Cabbage,		12 "
	60	do	s.	6 "
	75	do	s.	5 "
	61	Red Cabbage	s.	6 "
	61	Beet,	s.	11 "
	63	do		22 "
	67	do	s.	8 "
	79	do	s.	5 "
	58	Cucumber,		30 "
	81	do		7 "

It is stated that at Albany, N. Y., of Indian corn planted when the temperature of the soil was but 45° in the spring, the seed all rotted; but when planted, when the temperature was about 60°, it vegetated.

This subject is one of great importance to the farmer; large quantities of seed and labor are annually lost in consequence of inattention to such particulars; and there is yet much to learn that is valuable in this regard. The proper time for seed-sowing may be accurately ascertained by means of experiment; and by the use of the thermometer and meteorological tables.

134. As is well known, a ray of the sun's light, consists of *seven* rays of different colors, which, uniting, form the ordinary white light. But, besides this, the sun's rays contain three different kinds of rays: *(a,)* a ray of light; *(b,)* of heat; *(c,)* of chemical agency. The effect of these on vegetation is essen-

tially different. Yellow light, *(a,)* impedes germination, and accelerates that decomposition of carbonic acid, which produces wood and woody tissues. Under its influence, leaves are small and wood short jointed. Red light, *(b,)* carries heat, and is favorable to germination if abundance of water is present, increases evaporation, supports the flowering quality, and improves fruit. Under its influence, color is diminished, and leaves are scorched. Blue light, *(c,)* (also called *chemical action*, or *actinism,)* accelerates germination, and causes rapid growth. Under its influence, plants become weak and long jointed. *(Hunt.)* These three agencies exist in different proportions in the sunbeam in the spring, summer, and autumn. The blue, *(c,)* is greater in spring; the yellow, *(a,)* in summer. The blue, (chemical ray,) is less in the fall; and then the heating ray, red, *(b,)* predominates. Thus the sun's rays differ in their properties at different seasons of year; and are adapted to the peculiar needs of the plant at the time. Still further, the proportion of these agencies vary in different latitudes and climates. Daguerreotypes, depending on these principles, are poor in England, better in France, superior in New York, but best in the Northwestern States. Probably the *chemical* rays are more abounding in the above proportion, but there is yet much to learn on this subject; and it is not unlikely that the many differences known to exist in animal and vegetable life in these countries will be found to be more or less controlled by these peculiarities of the sun's rays. Gardeners have attempted to make practical use of these facts by means of colored glasses, but, apparently, without much success.

135. Rain is necessary for the life of most plants. In those countries where rain never falls, vegetation is either wanting, or —depending on dews—very limited. In other countries, where it only falls at a certain season, leaving many months at a time without a shower, plants only grow during the rains, and are parched up and disappear during the rest of the year. The

amount of rain that falls in a year is governed by known laws. It varies in different parts of the same country, but is nearly the same, each year, in any given locality.

Rain is measured, for meteorological purposes, by *inches*. The instrument used is called a *Rain Guage*, and sometimes a *Pluviometer*. They are of various forms, but all acting upon the same principle—that of receiving the rain into a vessel of known size, with a graduated measurer, divided into inches and parts of inches. The one generally used in the United States is known as the "Conical Rain Guage of DeWitt"—equally simple and perfect. It consists of a copper cone, with a perforated cap to prevent evaporation. It is fixed on a post, in a situation sheltered from winds, about 8 feet from the ground. The measurement is made by putting down perpendicularly to the bottom of the guage, a measuring stick, graduated in inches and their decimals.

136. In Agriculture, rain is important as regards *(a,)* the season, and *(b,)* the mode in which it falls, whether in heavy storms, with long intervals between them, or frequently, in small quantities at a time; and *(c,)* the direction from which it comes. If rain chiefly fell late in the Fall, in Winter, or in early Spring, vegetation would receive but little benefit from it. If it fell continuously at seed and harvest time, it would preclude cultivation; if it fell in heavy storms, with long intervals between them, plants would be alternately forced forwards, and retarded. Where rain is very constant, as in the mountains of England and Scotland, grass-growing and cattle-raising are substituted for grain. Consequently, the *annual* amount of rain is of less importance than the frequency of it, and the seasons of the year over which it is spread.

The annual amount of rains, averages:—

Under the tropics of the New World, -	115 inches.
" " " " " Old World, - -	76 "
Within the tropics generally, - - -	$95\frac{1}{2}$ "
In the United States, - - - -	45 "
Europe, - - - - - - -	$31\frac{3}{4}$ "
Generally over the world, - - - -	$34\frac{3}{4}$ "

Much more rain falls annually in the United States than in Great Britain, if a few mountain districts in the latter be excepted; but the mode of falling is different in the two countries.

The following table will serve as an illustration of this subject, although being drawn from single years, it is not strictly accurate as regards each locality:—

PLACE.		Rainy Days.	Inches.	Snowy Days.	Inches.
Truro, - -	England,	152	50		
Exeter, - -	"	150	33		
Bechington, -	"	185	35		
Greenwich, -	"	167	28		
Liverpool, -	"	190	31		
Highfield, - -	"	213	25		
Whitehaven, -	"	200	45		
Durham, - -	"	152	21		
Newcastle, -	"	140	30		
Saco, Maine, -	U. States,		44		
Cambridge, Mass.,	"		56		
Mendon, - "	"	*81½		26	
Worcester, "	"	88	37	24	61
New York, N. Y.,	"	57	39	8	31
Savannah, Geo.,	"	72	59		
Natches, Miss.,	"	87	75		
Ann Arbor, Mich.,	"	79	23	33	

* Average of 15 years

In England, more rain falls on the West than on the East side of the Island; and the practical effect is that more green crops, which require more moisture than grain, are grown on the former; such crops making a larger return on the western side.

137. Every inch of rain falling annually is equal to a weight of rather more than 112 tons on each imperial acre; so that the mean annual weight of rain falling in the United States, exceeds the mean amount of rain on the eastern coast of England, by several hundreds of tons per acre.

138. Another important consideration is *(a,)* the season of the year in which rain chiefly falls; and *(b,)* the distance of

of time which usually intervenes between one day of rain and another.

Thus, in 1841, according to the *Army Meteorological Register*, there fell at Detroit, Mich., and New Orleans, La., the following inches of rain and snow in each quarter of the year, in so many days:

DETROIT.	I.	II.	III.	IV.	N.ORLEANS	I.	II.	III.	IV.
Inches,	5.36	7.87	7.84	5.99	Inches,	31.50	9.90	7.17	11.96
Days,	25	20	19	30	Days,	30	3 ?	28	4 ?

Thus we see, that in Detroit, during this year, of 27.06 inches of rain, 11.35 or less than half fell during the six winter months; leaving 15.71 inches for the use of vegetation; while in New Orleans, 43.46 inches, or nearly three quarters of the whole year's supply, fell during the winter months, leaving only 17.07 for the six summer months. So that, while there is much less rain in Michigan, it is more equally distributed.

139. The yield of grains, and root crops depends upon the mode in which the rain falls, whether in light showers, and dense fogs; or in heavy storms; and at the particular time of vegetating or flowering. These particulars again vary according to the soil, whether it is sand or clay, drained or undrained. Thus oats appear to demand a constantly damp atmosphere; buckwheat and peas light showers while flowering; while wheat is apt to be injured by rust, if much warm rain falls at the time it is ripening. The size and average weight of stock also seem to depend upon the mode in which rain falls. The health of sheep is certainly dependent on this peculiarity of the climate; and the naturalization of varieties *probably* depends upon it.

Dr. P. A. Brown, of Philadelphia, observes "that if a line be drawn diagonally through the United States from the South-east corner of New Hampshire to Texas, it will be found, that the woolly sheep, (*Merino variety*,) will breed and thrive everywhere North-west of it, and the hairy sheep, (long-woolled varieties,) everywhere South-east of this line;

but that neither will thrive on the other sides, respectively, of that line, nor will they if the species are crossed." The same peculiarities are found in other parts of the world. The *cause* is not yet satisfactorily ascertained, but is undoubtedly more or less dependent on climate.

140. Through a perfectly dry argillo-calcareous soil, in a state of fallow, rain descends in one day six times the depth of the quantity fallen. Thus a fall of 4-10ths of an inch will sink in a day through nearly 2½ inches. *(Gasparin.)*

141. The power of the soil to absorb and retain moisture, is practically, an important consideration, and greatly influences the effects of the annual quantity of rain falling. The amount of water which a cubic foot of various soils can contain before they allow any of it to run off was determined by M. Schubler:

A cubic foot of

Siliceous sand held of water		27.3 lbs.
Calcareous sand	"	31.8 "
Sandy clay	"	38.8 "
Loamy clay	"	41.4 "
Stiff clay, or brick earth,	"	45.4 "
Arable soil	"	46.8 "
Garden mould	"	48.4 "

142. The relative degree of rapidity with which rain water is evaporated, was also ascertained. Of 200 parts of each earth exposed for four hours, on a thin surface in a closed room, at 65¾ Fahrenheit, there was an evaporation of absorbed water as follows:

Siliceous sand	lost	88.4	parts	in	100	parts of	absorbed water.
Calcareous sand	"	75.9	"	"	"	"	"
Sand clay	"	52.0	"	"	"	"	"
Loamy clay	"	45.7	"	"	"	"	"
Stiff clay,	"	35.9	"	"	"	"	"
Arable soil	"	32.0	"	"	"	"	"
Garden mould	"	24.3	"	"	"	"	"

It is readily perceived how different must be the effect of dry weather upon crops grown in these various soils.

4

143. Wheat, and probably other grains, vary in their quality and nutritive powers according to the warmth and relative dryness of the climate. Sir Humphrey Davy found in 1,000 parts of seed wheat in its natural state:

	Mucilage or Starch	Gluten.	Total.
From Middlesex, England, - -	765	190	955
Thick-skinned Scicilian Wheat, -	725	230	955
Thin-skinned Scicilian Wheat, - -	722	239	961
Wheat from Poland, - - -	750	200	950
North American Wheat, - - -	750	225	975

Thus the gluten of wheat, from the warm and dry climate of Sicily, far exceeded that of English wheat; while in wheat from the United States, the starch and mucilage, (the *heat-giving* constituents,) are nearly equal to those of England, and the gluten, (the *flesh-forming* constituent,) is far superior; or, in other words, the last is much more nutritious than the first.

"The real value of wheat and of the other cereals and bread stuffs depends mainly upon the proportion of gluten and albumen which they, contain, their starch, glucose, and dextrine, or gum, not being considered nutritive."—*(L. C. Beck.)*

According to Prof. Beck, American wheat flour shows the following comparative analysis:

Water, - - - -	11.75 to 14.05 per cent.
Gluten, - - - - -	9.90 to 14.36 "
Starch, - - - - - -	66.00 to 70.20 "
Glucose, Dextrine, &c., - -	4.96 to 11.05 "

144. The quantity of water contained in wheat greatly effects its value, as regards, *(a,)* keeping; *(b,)* the quantity of bread it yields.

(A.) Large amounts of Western flour are annually damaged by a chemical change which takes place, owing to the water contained in it. This water amounts, on an average from 24 to 26 lbs. in every barrel of common flour. The total annual loss to the United States, from this cause alone, was estimated, in

1847, at from $3,000,000 to $5,000,000. It is not only the sourness which injures flour; but the gluten, and therefore the nutritive quality, is actually diminished. In Poland, and in some parts of the United States, wheat is dried before grinding, in which case, no change takes place. As much as 18 lbs. of water have been expelled from a barrel of Ohio flour.

(B.) Wheat grown in dry climates yields more bread than when grown in wet climates. A quarter of English wheat has yielded 13 lbs. more bread than the same quantity of Scotch wheat.

Wheat grown in New Jersey, lower Pennsylvania, the Southern part of Ohio, Maryland, Virginia, the Carolinas and Georgia, contains less water, and more nutritive matter than that from the more northern States Experiments have proved that manures produce an effect similar to climate in raising the nutritive value of wheat, in proportion as they contain nitrogen; and it is not improbable that the manure received from the air in dry climates has an especial effect in this respect.

145. "It is impossible, when we are examining these facts, not to feel how closely the meteorology of a neighborhood influences even the composition of the grain which it produces. The English miller is well aware of these things; he mixes with the wheat produced in the damper districts of that Island the dry wheat produced in lands where the mean temperature is much higher, the rain-fall considerably less, and, in consequence, more free from moisture. Such facts, too, are of practical use to the agriculturist, for he well knows how, by improved systems of cultivation, the obstacles presented by even climate are overcome." *(C. W. Johnson.)*

There is no reason for believing that the moon has any influence on the weather, or the crops, except as imparting light and heat. There are many old superstitions still popular on this subject. It has been closely investigated both in Germany for fifty years, and in England for twenty, and no connection between the moon and the weather could be

detected. In every phase, the moon is the same to us, as a material agent, except as regards the power of reflected light; and no one supposes that moonlight produces wet or dry. Why, then, should that point in the moon's course, when it begins to emerge from the sun's rays, have any influence on our weather? Twice in each revolution, when in conjunction with the sun at new, and in opposition to it at the full, an atmospheric spring-tide may be supposed to exist, and to exert some sort of influence. But the existence of any such tide at all is denied, and the absence of fluctuations of the barometric pressure favors the negative of this proposition. Night-feeding birds and animals, however, and oysters, grow fat or thin, according to the state of the moon and tides. In Kentucky, horses are said to be subject to disease of the eye, amounting to blindness, during the period of full moon, which is not the case when the moon does not shine. Dark stables are the remedy; and the philosophy of the disease is easily understood.

In conclusion, every farmer is recommended to procure and use a good Barometer. It will, at all times warn him of the approach of rain and wind storms; and after a little experience, he will find no difficulty in deciding upon the weather for twelve or twenty-four hours in advance. When he goes to bed at night, he can make a shrewd guess whether it will rain or not in the morning; and during harvest he will be forewarned, and can prepare for rain, and thus often save his hay and grain from damage. At sea, a barometer is now of essential necessity. Mr. Redfield, of New York, has lately pointed out the great service it will render to those navigating our large lakes; and to the farmer, it is quite as useful. As agriculturists become more familiar with the barometer, they will cease to put faith in the weather-superstitions of the dark ages; and will find innumerable useful and interesting practical questions decided by it. There are two kinds in common use, the perpendicular or circular Barometer, depending for its action upon Mercury (Quicksilver); and the *Aneroid* Barometer—a French invention—depending on the action of gas in a thin metal case. The first is the most complete and expensive, but the latter is quite sufficient for ordinary purposes, is not easily damaged, and is much more compact. It requires, however, to be occasionally compared with a standard mercury barometer.

CHAPTER V.

FORMATION OF PLANTS.

146. It has been already stated that plants are formed of organic and inorganic elements, which they receive from the soil and air. (*See* § 81–93.) The living plant possesses the power of receiving into itself these bodies, of changing or digesting them, and of re-arranging them in a different way, so as to produce new substances. In the same manner a new born animal swallows milk, and changes the milk into blood, bones, muscles, brain, &c. The perfect tree is only air, water, and a portion of the soil in which it is growing; as the animal, a few months' old, is only milk in a different shape. If the soil does not contain all the materials requisite to form a plant, it either will not grow at all, or it will grow unhealthily.

147. A perfect plant consists of three parts, *(a,)* a root, which remains in the soil, *(b,)* a trunk or stem which branches into the air, and *(c,)* leaves. Each of these is differently formed, generally contains different proportions of the elements, and is endowed with a peculiar function.

148. The stems of plants differ in their construction, some being much more simple than others. The stem of a tree consists of three parts: *(a,)* the pith, in the centre; *(b,)* the wood surrounding the pith; and *(c,)* the barks which cover the whole. The pith consists of soft celular tissue *(or parenchyma,)* which is at first gorged with the nourishing juices of the plant, but

which in time become exhausted, leaving the older pith dry and light, or mere empty cells, which are of no further use to the plant. The wood consists of woody fibre, among which vessels are more or less copiously mingled, capable of carrying liquids up and down between the root and the leaves. The branches are only a continuation of the stem, and have a similar structure. The bark consists of three portions; *(a,)* the *liber* which lies next the wood; *(b,)* the outer bark, composed of two parts, 1, the green or cellular layer, 2 the corky layer, and *(c,)* the *epidermis* or skin which invests the whole.

149. The *root*, immediately on leaving the trunk or stem, has also a similar structure; but as the root tapers away, the pith gradually disappears, the bark also thins out, the wood softens, till the white tendrils, of which its extremities are composed, consist only of a colorless, spongy mass, full of pores, (or minute holes,) but in which no distinction of parts can be perceived. In this spongy mass, the vessels or tubes which descend through the stem and root, lose themselves, and by them these spongy extremities are connected with the leaves.

150. A leaf is an expansion of the stem. Like the stem therefore, the leaf is made up of two distinct parts, the *cellular* and the *woody.* The leaf is a highly organized structure, containing innumerable rounded globules, cells, and veins, regularly arranged. It is also full of pores through which air can enter.

151. In a growing plant, the sap enters by the extremities of the roots, *(spongioles,)* ascends through the vessels of the wood, and is passed over the inner surface of the leaf by the fibres which the wood contains. Thence, by the vessels in the green of the leaf, it is returned to the bark, and through the vessels of the inner bark it descends to the root.

CHAPTER VI.

WHEAT.—*(Triticum.)*

152. There are three kinds of grain on which mankind principally feed, *(a,)* Wheat, *(b,)* Rice, *(c,)* Indian Corn or Maize. Of these, Wheat is chiefly confined to the colder regions of the world; and, in the United States, is second in importance to Maize. It belongs to the botanical family of Grasses. It is not found in a wild state, and the country in which it originated is unknown.

Wheat has lately been produced by the continued cultivation of a plant wild on the shores of the Mediterranean, called *Ægilops.* This is no more extraordinary than the origin of most of our garden vegetables.

Wheat grows in a great variety of climates. In Europe, the polar limits are stated to be as follows:—

	LATITUDE.	Mean Temperature. (Fahr) of		
		YEAR.	WINTER.	SUMMER.
Scotland, (Ross-shire,)	58°	46°	35°	57°
Norway, (Drontheim,)	64	40	25	59
Sweden,	62	40	25	59
Russia, (St. Petersburgh,)	60°15′	38	16	61

The iso-thermal curve of 57° 2′, which appears to be the minimum temperature requisite for the cultivation of wheat passes, in North America, through the uninhabited regions of the Hudson's Bay country. At Cumberland House, lat. 54° N., long. 102° 20′ West, this grain is successfully raised. The

possible cultivation of wheat towards the Equator oscillates between lat. 20° and 25°. It is grown successfully in Chili, and Rio de la Plata. In southern Peru it grows at a height of 8,500 feet; and at the foot of the volcano of Arequipo, at a height of 10,600 feet.

The introduction of this grain into the United States was in 1602, when it was sown on the Elizabeth Islands in Massachusetts. In 1611 it was sown in Virginia; and in 1648 many hundred acres of it were cultivated in that colony; though it was afterwards neglected to give place to Tobacco. It was introduced into the Mississippi Valley in 1718, but owing to the character of the soil and climate, succeeded badly, running to straw instead of grain; yet in 1746 it became an article of export from the Wabash to New Orleans. The principal wheat-producing States are

	BUSHELS.		POPULATION.	
	1840.	1850.	1840.	1850.
New York, - - -	12,286,418	13,121,498	2,428,921	3,097,394
New Jersey, - -	774,203	1,601,190	373,306	489,555
Pennsylvania, - -	13,213,077	15,367,691	1,724,033	2,311,786
Delaware, - - -	315,165	482,511	78,085	91,535
Maryland, - - -	3,345,783	4,494,680	470,019	583,035
Virginia, - - -	10,109,716	11,232,616	1,239,797	1,421,661
Ohio, - - - - - -	16,571,661	14,487,351	1,519,467	1,980,408
Kentucky, - - -	4,803,152	2,140,822	779,828	982,405
Michigan, - - - -	2,157,108	4,925,889	212,267	397,654
Indiana, - - - -	4,049,375	6,214,458	685,866	988,416
Illinois, - - - -	3,335,393	9,414,575	476,183	851,470
Missouri, - - -	1,037,386	2,981,652	383,702	682,043
Wisconsin, - - -	212,116	4,286,131	30,945	305,191
Iowa, - - - -	154,693	1,530,581	43,112	192,214

During these ten years there was a gain on the whole crop of the United States of 15,645,378 bushels; while the crops of New England decreased from 2,014,000 to 1,090,000 bushels. In 1849, the wheat crop of the United States amounted to 100,503,899 bushels. It is estimated that one bushel of seed

is used for every ten bushels produced; and that an average of three bushels is annually used by every individual of the population.

153. Botanists distinguish *eleven* species or sub-species, viz:—

1.	*Triticum*	*œstivum*, - -	Spring Wheat.
2.	"	*hybernum*, - -	Winter Wheat.
3.	"	*compositum*, - -	Egyptian Wheat.
4.	"	*turgidum*, - - -	Turgid Wheat.
5.	"	*Polonicum*, - -	Poland Wheat.
6.	"	*Spelta*, - - -	Spelt Wheat.
7.	"	*monocuccum*, - -	One-grained Wheat.
8.	"	*compactum*, - -	Compact Wheat.
9.	"	*atratum*, - -	Dark-spiked Wheat.
10.	"	*hordeiforme*, - -	Barley-like Wheat.
11.	"	*Zea*, - - -	Far Wheat.

154. Of these, however, some may only be varieties. In the United States, two only, the Spring and Winter Wheat, are generally grown; though it is believed that Spelt may occasionally be met with as a spring wheat. The latter, which is the hardiest of the family, is cultivated in the south of Europe and Germany; and is known by its almost solid straw, and the chaff adhering to the grain so as to be separated with great difficulty. It may be grown on poor soils, but yields an inferior flour in small quantities. The others have no peculiar merit.

155. *Spring Wheat* was known in England as early as 1666, but has been cultivated only to a small extent there; and not to a much greater one in Scotland. In the United States, it does not appear to be as popular as formerly, except in districts, where Fall Wheat is apt to be killed during winter. As a general thing, the grain is not as large, contains more gluten, makes flour of a different quality and flavor, and brings a lower price in the market. Sir John Sinclair informs us that from 1767 to 1812 it was a practice with the best Scotch farmers to sow Fall Wheat

in Spring, from February to April, though March was generally the favorite month. The real Spring Wheat does not appear to have been generally known in that country till the begining of this century. Though sown in April or May it ripened as early as winter sown wheat. It was not, however so productive as winter wheat sown either in Winter or Spring, and the ears were shorter. There are many nominal varieties in the United States, the best probably being the Italian, the Siberian Bald, or Tea Wheat, and the Black Sea Wheat. Of this last there are again two varieties, the red and the white chaff; both of which are bearded. It is not known that the practice of sowing Fall Wheat in Spring has ever prevailed in this country, though there is no apparent reason why it should not succeed as well as in Scotland, and be profitable in certain localities. In the Northern States, it is considered important that Spring Wheat should be sown as early as the season will permit. The soil may be lighter than for the Fall variety; it ought to be in good condition; and is generally better if it has been plowed, and laid up dry in the Fall. From one and a half to two bushels is the proper quantity of seed per acre; more generally the latter. The after processes of harvesting and thrashing are similar to Fall Wheat.

156. The varieties of Fall Wheat are very numerous, differing not only in appearance, but also in constituents, in adaptation to soil and climate, in hardiness as regards disease and insects, and in productiveness. There appears to be one fact ascertained regarding them, which is, that they are constantly undergoing change in their relative productiveness. A new variety will be introduced into a given locality, and for a few years will succeed better than any other, after which it begins gradually to deteriorate in the qualities which at first recommended it. The ancient varieties appear to have been much inferior to some in the present day. There are four distinct divisions, *(a,)* White, *(b,)* Red, *(c,)* Bald, *(d,)* Bearded: the Red being *gen-*

erally hardier, but coarser than the White ; and the same may be said of the Bearded as compared with the Bald ; but in other respects there is no material *practical* difference.

General Harmon, of Wheatland, Monroe County, N. Y., who has devoted a long life to the study of and experiments upon Wheat, in 1844 gave the following as the best varieties known in the United States:

1. *White Flint,* probably introduced from the Black Sea into New Jersey, in 1814. Its peculiarities are, (*a,*) strong straw ; (*b,*) solid grain with thin bran ; (*c,*) the chaff adheres to the grain so that it does not readily shell out ; (*d,*) it is little affected by frost ; (*e,*) it has withstood the Hessian Fly better than any other now cultivated. Its usual yield is from twenty to twenty-five bushels per acre, but it has produced fifty-four bushels to the acre. 2. *Improved White Flint.* It is superior to the last in the size of the berry, the thinness of the bran, and the weight per bushel. 3. *White Provence,* introduced from France, (*a,*) it grows rapidly, yielding much straw ; (*b,*) ripens four or five days earlier than the common varieties ; (*c,*) withstands cold, and is not injured by insects ; but the straw is soft and it is apt to fall down. It is *bald,* berry very large and white ; yielding flour well and of good quality. 3. *Old Red Chaff,* originated in Southern Pennsylvania. It is a bald wheat, with red chaff but a white grain ; and in other respects is similar to the last. On new oak lands it succeeds admirably, but on old lands it is subject to rust, mildew, insects, and winter-killing. 4. *Kentucky White Bearded,* (*Hutchinson, Bearded Flint, Canada Flint,*) a white chaff, bearded wheat. 5. *Indiana Wheat,* originated in Indiana, a white chaff, bald wheat ; peculiarly adapted to strong soils. 6. *Velvet Beard,* or *Crate Wheat* ; introduced from England twenty-five years ago : a red chaff, bearded, large berried wheat. It is very hardy, not apt to be thrown out by frost, nor injured by insects. 7. *Wheatland Red,* originated from the *Virginia May,* by Gen'l Harmon : it is red chaff, bald wheat, and not apt to rust. 8. *Golden Drop,* an English variety. 9. *Mediterranean,* introduced from the South of Europe fifteen years since. It is a light red chaff, bearded, berry red and long, bran thick, and flour inferior ; but it is not injured by insects, and ripens early. 10. *Blue Stem,* cultivated in Virginia about fifty years since, but now generally grown in the Northern States. Formerly it was a red wheat, but it is now changed to a beautiful white. It is very productive.

This list might be much extended, but it could not be of any practical utility.

157. The qualities desirable in Wheat may be thus shortly enumerated: Straw of medium length and size, not apt to fall down, to be attacked by insects or rust, nor killed by frost or wet; able to *stool out* or *tiller*, so that each grain gives several roots and stalks. The heads long, well filled; the chaff adhering to the grain so that it does not easily shell: the kernel white, flinty, solid and large, with thin bran, and yielding a white homogeneous flour in large quantity of first quality; the skin elastic, not breaking up into small particles in grinding, and filling the flour with specks of bran so small as to be incapable of seperation; not apt to sprout if necessarily exposed to wet after harvesting; germinating rapidly, and growing steadily after sowing. Any wheat that united all these qualities would be nearly perfect.

158. Wheat is expected to weigh sixty pounds to the American bushel. The crop varies from eight to sixty bushels to the acre; the average throughout the United States is between twelve and fifteen bushels per acre. Occasionally a bushel of wheat will weigh as high as sixty-six pounds.

The American Bushel contains, - - -	2,150.42 cubic inches.
The English (Imperial) Bushel contains -	2,218.192 "

The English *quarter* of Wheat is eight Imperial Bushels of 70 lbs. each, equal to 9⅓ American Bushels of 60 lbs. each. Wheat is sold in the States by the Bushel of 60 lbs. In England by the quarter of 560 lbs.

159. Ultimate ANALYSIS of Wheat grown at Bechelbronn, 1837.—*(Boussingault.)*

	GRAIN.	STRAW.	
Carbon,	46.10	48.48	48.38
Hydrogen,	5.80	5.41	5.21
Oxygen,	43.40	38.79	39.09
Nitrogen,	2.29	0.35	0.35
Ash,	2.41	6.97	6.97
	100.00	100.00	100.00

160. The composition of Wheat varies greatly according to

many circumstances, such as *(a,)* the soil; *(b,)* the manure used; *(c,)* the variety; *(d,)* the climate; *(e,)* the time it is harvested, &c. The following analysis by Sprengel may be taken as an average. 100,000 parts dry wheat contain 1177 parts of ash or inorganic matter; the same quantity of wheat straw contains 3518 parts of ash. They consist of the following substances:

	GRAIN.	STRAW.
Potash, - - - -	225	20
Soda, - - - -	240	29
Lime, - - - -	96	240
Magnesia, - - - -	690	32
Alumina, - - - -	26	90
Silica, - - - -	400	2870
Sulphuric Acid, - - -	50	37
Phosphoric Acid - - -	40	170
Chlorine, - - - -	10	30
	1777	3518

161. Analysis of the organic, or combustible portion. 100 parts of wheat in its natural state contain. *(Gregory.)*

Albumen, - - - - - -	3.0
Gluten, - - - - - -	9.9
Starch, - - - - - -	55.7
Gum, Dextrine, Pectine and Sugar, - - -	4.6
Fibre and Husk, - - - - -	11.9
	82.31

162. Or according to another analysis *(Gregory,)* the parts may be thus divided:

Water, - - - - - - -	12.9
Organic Matter, - - - - - -	85.2
Ash, - - - - - - - -	1.90

163. The influence of variety of seed and mode of culture are shown by the following results of the examination by Boussingault of several varieties of wheat grown in the *Botanic Garden* at Paris:

	Husk or Bran in the grain, per cent.	Water in the Flour, per cent.	Flour in the grain, per cent.	Gluten, &c. in the Flour, per cent.
Cape Wheat, - -	19	81	7.0	20.6
Russian Wheat, -	18	82	6.4	24.8
Dantzig Wheat, - -	24	76	7.3	25.8
Red Foix Wheat, -	18.5	81.5	9.3	26.1
Barrel Wheat, - -	22	78	8.8	27.7
Winter Wheat, - -	38	62	14.1	33.0

164. The time of cutting affects the weight of produce, as well as the relative proportions of flour, bran, and gluten. Thus from three equal patches of the same field of wheat in Yorkshire, cut twenty days before the crop was ripe, ten days before ripeness, and when fully ripe, the produce was in *grain*. (*Johnston.*)

20 days before.	10 days before.	Fully ripe.
166 lbs.	220 lbs.	209 lbs.

and the per centage of flour, sharps, and bran, yielded by each, and of water and gluten in the flour was as follows:

When cut.	in the grain, per cent.			in the flour, per cent.	
	Flour.	Sharps.	Bran.	Water.	Gluten.
20 days before it was ripe,	74.7	7.2	17.5	15.7	9.3
10 days before, - -	79.1	5.5	13.2	15.5	9.9
Fully ripe, - -	72.2	11.0	16.0	15.9	9.6

When cut a fortnight before it is ripe, therefore, the entire produce of the grain is greater, the yield of flour is larger, and of bran considerably less, while the proportion of gluten contained in the flour appears also to be in favor of that which was reaped before the wheat was fully ripe.

165. Bran, as is well known, constitutes, notwithstanding its dry appearance, a very excellent food, and is fattening for stock. Used in bread, it adds much to the nourishing qualities of it, especially in the case of children. The average composition of it is represented as follows: (*Johnston.*)

Water, - - - - - -	13.1	per cent.
Albumen, (coagulated,) - - - -	19.3	"
Oil, - - - - - -	4.7	"
Husk and a little starch, - - - -	55.6	"
Saline matter, (ash,) - - - -	7.3	"

The following is a more minute analysis of Bran from a Soft French Wheat, grown in 1848: *(Millon.)*

Starch, dextrine and sugar, - - - -	53.00	per cent.
Sugar of Liquorice, - - - - - -	1.00	"
Gluten, - - - - - -	14.90	"
Fatty matter, - - - - -	3.60	"
Woody matter, - - - - -	9.70	"
Salts, (inorganic,) - - - - -	0.50	"
Water, - - - - - -	13.90	"
Incrusting matter and aromatic principles, - -	3.40	"
	100.00*	

A large portion of the inorganic matter in Bran is Phosphate of Magnesia, a very valuable salt both in food and for manure. Common bran, however, owing to the flour adhering to it, is generally much richer than the above analyses.

166. The following is another view of the constituents of wheat, being the extremes of fourteen analyses of as many different varieties, lately made by *Peligot*:

Water, - - -	13.2 to 15.2	per cent.
Fatty matters, - - - - - -	1.0 to 1.9	"
Nitrogenous matters insoluble in water, -	8.1 to 19.8	"
Soluble Nitrogenous matter, (albumen,) -	1.4 to 2.4	"
Dextrine, - - - - -	5.4 to 10.5	"
Starch, - - - - -	55.1 to 67.1	"
Cellulose, (woody matter,) - - -	1.4 to 2.3	"
Saline matter, - - - -	1.4 to 1.9	"

*The reader is referred for further information on the nutritious value of Bran to an Essay by Prof. J. F. W. Johnston, published in Edinburgh, Scotland; and to the Report of Prof. L. C. Beck in the *Patent Office Report* for 1849, p. 55. Dr. Daubeny observes "that according to the experiments of Magendie, animals fed upon fine flour died in a few weeks, while they thrived upon the whole meal bread. Brown bread, therefore, should be adopted not merely on a principle of economy, but also as providing more of those ingredients which are perhaps deficient in the finer parts of the flour."

167. The composition of wheat may, therefore, be roughly stated, as:

Heat-producing	constituents,	Starch, Sugar, Gum, -	50 to 60	per cent
Flesh-forming	"	Gluten and Albumen,	16 to 18	"
Water, -	"		10 to 18	"
Useless,	"	woody fibre, -	22 to 26	"
Inorganic,	"	various salts, -	2 to 4	"

168. In damp climates, such as that of Great Britain, the grain of wheat is generally larger and plumper than in hot, dry climates; but analyses show that the small grain raised in the hotter and drier air greatly surpasses the former in its nutritive value.

169. Prof. Beck, in his numerous examinations, found that the wheat and wheat-flour of the United States are equal to, if not greater in nutritive value than those afforded by samples produced in any other part of the world.

170. The following is an analysis of Michigan *(A,)* and of Richmond Mill *(B,)* Flour: *(Beck.)*

	A	B
Water, - - - - -	12.25	11.70
Gluten and Albumen, - - -	10.00	13.00
Starch, - - - - -	67.70	67.50
Glucose, Dextrine, &c., - - -	8.75	6.90
Bran, - - - - -	0.75	0.50
Ash, - - - - -	0.55	0.40
	100.00	100,00

171. The proportion of gluten in flour not only increases the nutritive value, but also the economical. It is to the peculiar mechanical property of this gluten that wheat flour owes its superior power of detaining the carbonic acid engendered by fermentation, and thus communicating to it the vesicular, spongy structure so characteristic of good bread. Where the proportion of gluten is large, the bread, absorbing more water, &c., weighs heavier. Thus, on an accurate and careful experiment, two pounds of Cincinnati flour, and two pounds of Alabama

flour were each, separately, mixed with a quarter of a pound of yeast, and were made into loaves and baked in the same oven.

The Cincinnati loaf weighed - - - - 3 lbs.
The Alabama loaf weighed - - - - - $3\frac{1}{2}$ lbs.

The gain in the latter is 22 per cent. over the former; or five barrels of Southern flour are equal to six of Northern flour. (*Pat. Off. Rep.*, 1846, p. 150.)

172. When fermentation, or *rising*, in bread is affected by the addition of yeast or leaven to the paste or dough, the character of the mass is materially altered. A larger or smaller proportion of the flour is virtually lost; according to Dr. W. Gregory it amounts to a loss of one sixteenth part of the whole of the flour. To avoid this, it has been recommended to raise bread by means of carbonate of soda and muriatic acid, which produce the same effect as yeast, while the sugar and gluten are saved; these two former materials forming common salt; and giving off carbonic acid gas.

173. The best SOILS for Wheat are those which contain a good proportion of clay and lime. Light and sandy soils do not usually produce good wheat.

Boussingault gives the following classification of soils:

Soils according to composition.	Usually Designated.	Clay.	Sand.	Lime or Chalk.	Humus.
Clay with humus,	Rich wheat land,	74	10	4	11.5
" " "	" "	81	6	4	8.5
" " "	" "	79	10	4	6.5
Marly Soil,	" "	40	22	36	4
Light soil, with humus,	Meadow land,	14	47	10	27
Sandy Soil, humus,	Rich Barley land,	20	67	3	10
Argillaceous land,	Good Wheat land,	58	36	2	4
Marly Soil,	Wheat land,	56	30	12	2
Argillaceous land,	" "	60	38		2
Stiffer " "	" "	48	50		2
Clay,	" "	68	30		2

Soils according to composition.	Usually designated.	Clay.	Sand.	Lime or Chalk.	Humus.
Stiff argillaceous land,	Barley land, 1st class,	38	60		2
" " "	" " 2d class,	33	65		2
Sandy Clay,	" " "	28	70		2
" "	Oat land,	23.5	75		1.5
Clayey Sand,	" "	18.5	80		1.5
" "	Rye land,	14	85		1
Sandy Soil,	" "	9	90		1
" "	" "	4	95		0.75
" "	" "	2	97.5		0.5

Besides these constituents, a good wheat soil should contain a notable proportion of potash, soda, phosphoric acid, and nitrogen. In Great Britain, the introduction of turnips and clover culture and drainage has greatly extended the range of wheat producing soils; this grain being now cultivated in rotation, with profit, even on sandy soils; so true is it, that science can adapt the earth and climate to almost any crop which it is desirable to cultivate.

174. Wheat, is considered a *scourging* crop, rapidly impoverishing the soil, in consequence of its requiring for its composition large quantities of materials, chiefly inorganic, which are naturally rare in soils. In this respect, it is placed at the head, of *grains*. According to Boussingault, a medium crop of wheat takes from one acre of ground:

	Dry Crop.	Ash, Per Cent.	Quantity of Ash Per Acre.	ACIDS.		Chlorine.	Lime.	Magnesia.	Potash and Soda.	Silica.	Oxide of Iron, Alumina, &c.
				Phosphoric.	Sulphuric.						
	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Wheat, - - -	1052	2.4	25	12	0.3		0.8	4	7	0.4	
Wheat Straw, - -	2558	7.0	179	5	1.5	1	15	9	17	121.	1¾
Total, - - -	3610	9.4	204	17	1.8	1	15.8	13	24	121.4	1¾

An average crop takes of organic matter the following, in grain and straw:

Carbon, - -	2259 lbs.	Oxygen, - -	1923 lbs.
Hydrogen, - -	262 "	Nitrogen, - -	52 "

or, as Ammonia, 63 lbs.

In consequence, it is found, in practice, that it is impossible even upon the best wheat soils, to grow this grain for several years in succession, without injuring the land; and, in most cases, the crop becoming so small as to be unprofitable. What is taken away must be replaced either directly by manures, or by growing other crops which do not require the chief constituents of wheat.

175. There are many rich soils in the Western States, such as Prairies, and River Bottoms, in which wheat runs to straw, and produces very little grain. This is commonly said to be owing to the land being "*too rich;*" but, in reality, it must be in consequence of a deficiency of some constituents of the wheat; which judicious manuring would supply. We are not aware that a comparative analysis of such lands has been yet made, but they will probably be found deficient in the alkalies and lime.

176. The manures for wheat necessarily vary according to the nature of the soil, and the mode in which it has been cropped. It may, however, be stated as general proposition, that our wheat lands appear deficient in *ammonia*, and that they cannot fail to be benefitted by nitrogeneous manures, such as guano, flesh, blood, sheep-dung, *well-saved* barn-yard manure, and such like.

There are probably few fields in the country in which the crop may not be greatly increased by judicious manuring; and very many that require manures to continue them at or bring them up to their original fertility.

177. It has been already stated (§159,) that the composition of wheat varies greatly according to the manure employed.

Thus, manures which are rich in nitrogen *(ammonia,)* not only increase the crop, but also produce a grain richer in gluten, and therefore intrinsically more valuable. On ten patches, each one hundred square feet, of the same soil (a sandy loam,) manured with equal weights of different manures in the dry state, Hermbstadt sowed equal quantities (½ lb.) of the same wheat,—collected, weighed, and analyzed the produce. His results are represented in the following table:

	Ox Blood.	Night Soil.	Sheep's dung	Goat's dung.	Human Urine.	Horse dung.	Pigeon dung	Cow dung.	Vegetable Manure.	Unmanured
RETURN	14 fld	14 fld	12 fld	12 fld	12 fld	10 fld	9 fold	7 fold	5 fold	3 fold
Water, - - - -	4.3	4.2	4.2	4.3	4.2	4.3	4.3	4.2	4.2	4.2
Gluten, - - -	34.2	33.9	32.9	32.9	35.1	13.7	12.2	12.0	9.6	9.2
Albumen, - -	1.0	1.3	1.3	1.3	1.4	1.1	0.9	1.0	0.8	0.7
Starch, - - - -	41.3	41.4	42.8	42.4	39.9	61.6	63.2	62.3	65.9	66.6
Sugar, - - - -	1.9	1.6	1.5	1.5	1.4	1.6	1.9	1.9	1.9	1.9
Gum, - - - -	1.8	1.6	1.5	1.5	1.6	1.6	1.9	1.9	1.6	1.8
Fatty oil, - -	0.9	1.1	1.0	0.9	1.0	1.0	0.9	1.0	1.0	1.0
Sol. phosphates, &c	0.5	0.6	0.7	0.7	0.9	0.6	0.5	0.5	0.5	0.3
Husk and Bran,	13.9	14.0	13.8	14.2	14.2	14.0	14.0	14.9	14.0	14.0
	99.8	99.7	99.7	99.7	99.7	99.6	99.8	99.7	99.8	99.7

It must not, however, be forgotten, that these are *garden* experiments; and while the theory is probably quite true, in *field* culture the farmer may be unable to produce exactly the same results. Such experiments must be considered rather as illustrating a general principle, than as positively useful in practice, except to a limited extent.

178. The only mode in which a farmer can *judiciously* use manure, is by having an analysis of his land, showing what constituents are soluble, what may easily be rendered so, and what is wanting.

179. In many parts of the United States, wheat soils are manured by the complex action of clover, plaster (*sulphate of lime*) and sheep dung. The philosophy of this is as follows: The surface soil is naturally, or

has become by cultivation deficient in soluble lime and sulphuric acid, two constituents consumed in large quantities by clover; and which must be supplied before clover can grow. The clover is therefore sown with powdered plaster which contains these two elements, and it grows luxuriantly. But while the surface soil has been impoverished, the subsoil remains full of salts; and the clover sends down its deep tap roots into the subsoil, collects such inorganic matter as its finds there, and brings it to the surface. The sheep eat the green part, and scatter the constituents of the clover over the ground, *together with* the ammonia formed in the urine. The clover is then plowed up, and all that it has received from the subsoil and the air, is again rendered more or less soluble by decay, and supplied to the surface soil where the wheat roots find it. This can scarcely be called *real* manuring. With the exception of a little lime and sulphuric acid, nothing is supplied to the field but what it or the air contained before. The clover has acted as a *collector*. It has brought together on the surface what was before scattered in the subsoil, but it affords *nothing new*. The effect, in time, of such practice must be, that not only the surface but the subsoil also becomes impoverished; and each crop of wheat carries off the constituents of a larger area, than it could possibly do without clover. Unless, manures from the barn-yard or other sources are also supplied, the soil must, finally, be very seriously injured.

180. There are various modes of preparing the land for Wheat; *(a,)* summer following, with three distinct plowings, *(b,)* plowing once; *(c,)* plowing once and rendering the surface mellow with a cultivator; all of which have their advocates, and all are probably good for peculiar soils, and under peculiar circumstances. (See PLOWING.)

181. There are also various modes of covering the grain, *(a,)* by a harrow or drag; *(b,)* by plowing it in with a shallow furrow with a plow or cultivator; *(c,)* by ribbing; *(d,)* with a Drill Machine. (See IMPLEMENTS.)

182. Wheat is sown *(a,)* either broadcast by hand or by a machine; *(b,)* by a drill; or in England *(c,)* by a dibble.

183. It is harvested *(a,)* by hand with a sickle or reaping-hook; *(b,)* with a cradle; *(c,)* by a machine worked by horses.

In all cases, it is usually bound with a band made of its own straw into *sheaves*, and set up in *shocks* to dry.

184. It is either *(a,) stacked* out of doors, or *(b,)* put into a barn; *(c,)* or thrashed in the field.

185. It is thrashed *(a,)* by a flail; *(b,)* by horses or cattle treading on it; *(c,)* by a machine moved by horse-power; *(d,)* or, among the French, by a machine called *Le Diable.*

186. The chaff is separated from the grain by *(a,)* a Fanning Mill, or *(b,)* by the wind.

186. It is then ready for *(a,)* storing in the granary, or *(b,)* sending to market, which is usually done in bags holding two measured bushels.

188. It has been already stated (§163) that the comparative ripeness affects the weight and quality of the grain. The best practical rule is to cut when a grain of wheat pressed between the finger and thumb is easily crushed, and yields a considerable quantity of juice; and when the straw is still more or less green, especially near the root. Some experience, however, is requisite in determining the exact time.

189. For *seed*, on the contrary, wheat should be allowed to stand until it is quite ripe; and then selected with care. The best wheat is raised from seed carefully selected from large heads. In former days, when wheat was winnowed by the wind, the largest and heaviest grains were preserved for seed. Great improvement, both in the variety and crop, may undoubtedly be affected by exercising care in this particular. Experiments seem to prove that wheat thrashed by a machine frequently has the germinating power destroyed; and though it may throw out leaves is deficient in roots, and therefore perishes.

The *Boston Cultivator*, 1845, gives an instance of a farmer in Vermont, who saved his seed wheat, who used, before thrashing, to select the best sheaves, and striking them over the side of an empty barrel as it lay on the floor, three or four times, he obtained a very superior seed wheat. Thus the largest and ripest kernels were seperated and collect-

ed. While the process was kept secret, so high a reputation had this wheat, that the neighbors willingly paid double the usual price for it.

190. The quantity of seed sown to the acre varies in the United States from one and a half to two bushels, *broadcast;* and about one bushel if drilled. In Great Britain, where much more seed of all the cereals is sown than with us, three to four bushels is the usual quantity, when broadcast.

191. The waste of seed in the soil is very great, especially when broadcast; chiefly in consequence of the irregular depth at which the grain is planted. The following calculation has been made, *(Stephens.)* "Wheat at 63 lbs. to the bushel, gives 87 of its seeds to the drachm; or 701,568 to the bushel (in apothecary's weight,) or 865,170, (in avoirdupois weight.) Now three bushels of seed are sown on the acre, or 2,595,510 grains of wheat. Suppose that each grain produces one stem; and every stem bears an ear containing the common number of 32 grains, the produce of the acre should be 96 bushels; but the heaviest crop in Scotland rarely exceeds 64 bushels to the acre, or 33 per cent. of the seed is lost in the best crops, and 58 per cent. in an ordinary one of 40 bushels." It is very important that such experiments as these should be made in the United States, so as to ascertain the exact quantity of seed to be sown in each soil and climate.

192. The depth at which seeds are sown, is also very important. In order to germinate, a seed must have acccess to moisture, air, and warmth, but be excluded from light. If covered too deep, it will not sprout; if too shallow it is apt to perish for want of moisture and from other causes. Seeds of different plants germinate at various depths. It is laid down as a rule that wheat sown before winter should be as deeply covered with earth as to be beyond the reach of injurious frost, say four or five inches; but when sown in spring it should be lightly covered, little exceeding one inch. In no case should wheat be deeper than six or seven inches. In light dry soils it should be

deeper than in wet adhesive clays; and where clods are numerous more seed is requisite than where the earth is in fine tilth. The following table is given on the authority of M. Moreau, of Paris. He formed thirteen beds in which he planted one hundred and fifty kernels of wheat at various depths:

At Depth of	Came up.	No. of Heads.	No. of Grains.
7 inches,	5	53	682
6¼ "	14	140	2,520
5¾ "	20	174	3,818
4½ "	40	400	8,000
4¼ "	73	700	16,500
3¾ "	93	992	18,534
2¾ "	123	1417	35,434
2⅓ "	130	1560	34,349
2 "	140	1590	36,480
1¾ "	142	1660	35,826
1 "	137	1561	35,072
1½ "	64	529	10,587
On surface,	20	107	1,600

From these experiments it would appear that the grain should not be sown at much greater depth than two inches, nor nearer the surface than one inch. The soil is not stated.

193. Wheat a year old is considered to be better for sowing in the Fall than new wheat. New wheat germinates quicker, but is more easily affected by bad weather and insects, and generally the stalks are neither as numerous nor as strong.

194. Wheat is frequently *steeped* or pickled *(a,)* to act as a manure; *(b,)* to destroy the sporules or seeds of smut. Various substances are used, as *(c,)* salt and water; *(d,)* green vitriol, *(sulphate of iron,)* *(e,)* stale urine; *(f,)* arsenic, &c. Arsenic, however, has been proved to be decidedly dangerous to the sower, and the use of it is forbidden by the French government. Various modes of steeping, according to convenience, are used; and the seed is dried with wood ashes, plaster, slacked lime, powdered clay, &c.

195. In *judging* of seed wheat, the dimpled end of the grain should be distinctly marked, and the point from which the little roots proceed must be somewhat prominent; the end from which the blade springs should also be slightly covered with hairiness or wooliness. The little protuberances at either of those ends must not have been rubbed off, as the grain is thereby deprived of vitality. Kiln-drying spoils grain for sowing. It may be known by unusual hardness, and a smoky odor. Wheat that has heated in the stack will taste bitter; if slightly sprouted, sweet; and if long kept in the granary it will smell musty, and look dull and dusty. If eaten by the weevil it may be detected by pressing the kernel with the fingers. If *rusted* it will be shrunk; if *smutty*, it will have a black appearance and a peculiar smell.

196. The weeds that principally injure wheat in the United States are *(a,)* Cockle, *(Lychnis Githago;)* *(b,)* Chess or Cheat, *(Bromus secalinus;)* *(c,)* Pigeon-weed, or Red-root, Steencrout, Stony-seed, Wheat-thief, *(Lithospermum arvense;)* *(d,)* (chiefly in spring wheat,) Field-mustard or Charlock, *(Sinapis arvensis;)* *(e,)* Vetch, or Black-pea, Tare, *(Vicia sativa ?* and *Americana?)* *(f,)* Wild-radish, *also called* Charlock. *(Raphanus Raphanistrum.)* These are all annuals; for perennial weeds are confined to no particular crop.

Cockle (*a*,) is a strong growing upright plant, one to two and a half feet high, with a purple flower, and seed pod full of black seeds. It injures the wheat chiefly in grinding for flour, discoloring it, and giving an unpleasant bitter flavor.

Chess, (*b*,) a species of grass. There are two other species of the same genus indigenous to the United States, and two more introduced from England. The leaves and stalk, in their earlier stages, greatly resemble wheat, but the flowers, stamens, and seeds, are very different. It grows chiefly in soil plowed in the Fall, but is also met with in meadows, and among spring crops, where no wheat was ever sown. It is probably a native of most parts of the Northern States, and like other weeds, the germs are contained in the soil ready to vegitate as soon as the conditions of growth are favorable. The seeds are very numerous.

Seven thousand kernels have been counted growing from one root; enough to seed *three hundred* acres thickly the third year, were it cultivated. They are also very difficult to destroy, passing through animals and fowls without losing the germinative power. It was formerly as plentiful in England as it is with us, but by care in sowing clean seed, it is now all but exterminated. There is a notion among some farmers that "wheat turns into chess;" but this is wholly opposed to all facts and analogies; and the belief may be classed among the superstitions of the dark ages that still linger in our profession. (See *Patent Office Reports*, 1849, p. 455; 1851, p. 650.) By sowing wheat seed perfectly clean of chess, it soon disappears. It is chiefly troublesome by drawing the nourishment from the growing wheat, and overpowering it; and injuring the flour. When crushed, it is good food for horses and poultry, and if boiled, for hogs.

Pigeon-weed, (*c*,) has been introduced from Europe. It is an annual plant "slender, hoary with minute oppressed hairs, somewhat branched; leaves lanceolate, acutish, nearly veinless; racemes few-flowered, the lower flowers remote; corolla (yellowish white) not longer than the calyx." (*Gray.*)

This weed appears to be confined to certain soils, such as in New York are known by the name of Marcellus Shales, and in Michigan, as Oak Openings, and Burr Oak Plains. In this latter State, it is found in the Interior, while it yet seems to be unknown in the heavy clays, forming a belt around the Peninsula. Where it becomes plentiful it is exceedingly injurious to the wheat crop. It is not above thirty years since it was introduced into New York, and it has now spread wherever it finds a congenial soil. The peculiarities of the character and habit of this weed consist (*a*,) in the hard shell with which its seed or nut is covered; (*b*,) in the time at which it comes up and ripens its seed; (*c*,) in the superficial way in which its roots spread. The seed is so hard that it passes uninjured through cattle and birds, and lies for years in the ground without perishing. It grows very little in spring, but shoots up and ripens in the Fall, and its roots spread through the surface soil only, and exhaust the food by which the young wheat should be nourished. It is said to be so prolific as to increase more than two hundred fold annually. When it has once got into the land, two or three successive crops of wheat will give it entire possession of the soil. In Yates County, N. Y., the seeds are crushed with linseed, for the oil they contain, which is about 4 lbs. per bushel; and for the addition which the husk makes to the *oil cake*. The only mode of exterminating it is, when slight, to pick it out of the growing wheat by hand; and when

abundant, to plow once or twice in the fall, after the seed has sprouted; and to cultivate spring hoed crops, avoiding wheat for some years. The seed must on no account be mixed with manure or given to stock, as it will thus be spread everywhere. As ordinary care and good farming will prevent its spreading further west, and as, in lands that suit, it is the most injurious wheat-weed in the United States, it is important that the whole community should attend to it. If allowed to grow on one farm, it will inevitably spread to others, being carried by birds, and other means.

Field Mustard (*d*,) and Wild Radish, (*f*,) are known by their bright yellow flowers. They are injurious by taking the place of the grain, and overpowering it. The seeds are small, numerous, and very persistent. The best mode of eradicating these plants, is to pull them by hand when in blossom.

Vetch, (*e*,) is a small creeping pea-like plant, adhering to the grain by its tendrils. In some soils it is very plentiful; and is chiefly injurious in grinding, discoloring the flour and giving it a bad flavor. The seeds are small, round, and black. It may be exterminated by one or two hoed spring crops, and laying the land to pasture for a year or two. A good fanning-mill would probably clean the grain completely, but the writer has seen wheat brought to mill in Western Canada, containing one third of the seeds of the Vetch. It appears to be confined to rich clay and loamy lands.

197. The parasitic fungi which are injurious to wheat are (*a*,) Smut or Bunt; (*b*,) Rust; (*c*,) Mildew.

A *Fungus* is a cellular flowerless plant, deriving its nutriment by means of spawn. It lives in air, and is propogated by *spores*, which are naked, or by *sporidia*, so called when enclosed in little vesicles. *Fungi* may be said to consist of a mass of little cells, or little threads, or of both combined in various ways. They have no seed or fruit except their *sporules*, *spores* or *sporidia*, of which the methods of attachment are singularly curious and beautiful. They derive their nourishment from the substance on which they grow, and not from the media in which they exist, Well known *Fungi* are Mushrooms, Toadstools, Puffballs, mould on cheese, &c., most of which are poisonous. Many of them grow on living plants, as Smut and Rust; but the small ones, to a great extent, on animal substances in a state of partial decay; or where they can find nitrogenous compounds, as in bread, &c. The spores are often of exceeding minuteness, and epidemic diseases have

been attributed to their influence. Certain species are found in the living human body; and in the inferior animals. These are called *Entophyta*. A striking instance is the disease which kills so many silkworms, known as the *Muscardine*, where the Fungus is planted in the skin and grows externally. Dr. Leidy,(*Smithsonian Contrib. to Knowl.*) has described ten species of this order found in men.

198. There are two species of Smut, *(a,)*; the one *(b,) Uredo caries*, or *fœtidum*, a brownish black dust, greasy, and fetid, taking the place of the kernel of wheat. It does not appear externally, being confined within the husk. The other *(c,) Uredo segetum*, (Black ears, Brand, Dust Brand, Burnt Corn, &c.,) is met with in Barley and Oats as well as Wheat. It resembles a black dust, growing within the glumes of the plant. It destroys the seed, and its envelopes. The spores are so small that a square inch could contain 7,840,000 of them, and within these again are inumerable sporoles. Smut *(a,)* is undoubtedly propagated from the wheat seed to the living plant. M. Bauer (*Trans. of Linnean Soc'y., London, vol. xviii., p.* 468,) has shown that "Smut-balls" on grain can certainly be produced by inoculating the seed with the sporoles of the fungus. These bodies are carried into the interior of the plant by the sap, after being absorbed by the roots. Johnston says it can be seen where they have come up through the stalk. When examined, the tubes of the stalk were filled with black matter that had come through the vessels, affecting first the straw, then getting into the ear, whence it spreads itself all over. Thousands of the sporules may be attached to a single grain of wheat, and yet be invisible to the naked eye. This disease is most common on damp undrained soils, with impervious subsoils ; and may be eradicated by *(a,)* thorough draining of the land; *(b,)* and by washing the grain previous to sowing in some saline mixture (§193) and drying with slacked lime.

199. Of Rust *(b,)* there are also two species. One *(c,)* is found scattered over the inner surface of the outer chaff scales, the skin of which is raised into blisters. This is called by

Botanists *Uredo rubigo;* it is of an orange yellow color; and when severe, causes the grain to shrink, and prevents maturation. The other *(d,) Uredo linearis* is confined to the straw and leaf, and is the color of the rust of iron. It causes the epidermis to split, and it is supposed to permit the emission of the juices. The grain is affected by this in the same manner as by the former.

Wet soils are most subject to these fungi, but they especially appear during sultry, wet weather towards the flowering of the plant.

200. Mildew (i. e. *mel-dew,* from an old notion that it was produced by *honey-dew* falling from the air,) or Blight, *(c,)* is produced by *Puccinia graminis.* It forms blackish brown parallel, lives upon the straw, and seems to affect the entire plant, so that it deprives the sap of the power to form seed in a healthy state, and hence the grain is very much shrivelled, or no grain at all is formed. The spores of this fungus enter the straw by its breathing pores, which are closed in dry weather, but opened in a wet or damp atmosphere. This disease, like the last, attacks the plant in warm, moist weather, and often with remarkable suddeness and severity. Wet soils, and overmanured land are chiefly subject to it; and earth containing a large proportion of the salts of iron appears to add to the tendency. Draining is probably the only cure.

201. Wheat is also subject to attacks from various insects. The injury caused by these is sometimes so great and permanent as to prevent the culture of wheat at all, as has been the case in some parts of New England and New York. We shall shortly enumerate those most common in the United States, referring the student for scientific descriptions to *Dr. T. W. Harris' Treatise on some of the Insects of New England which are injurious to vegetation, 2d. Ed., Boston,* 1852, and for further information to the *Patent Office Reports* from 1844,

and to the older volumes of the Agricultural Periodicals of the United States.

202. *(A,)* Insects injurious to the seed, *when sown*, and to the young plant:

In Indiana, wheat has been injured both before and after germinating by a "red ant." It bores a small hole into the kernel, and consumes the germ; or cuts off the sprout, and eats into the grain. Drilled wheat appears to escape these ravages. (*Annual Report of Indiana State Board of Agriculture*, 1852. 2. The *Prairie Farmer*, in 1844, describes a small fly, a little more than an eighth of an inch in size, with four wings, and the odor of a bed-bug, which did much injury in Illinois. It first destroyed the heads of wheat previous to harvest; it then took to the corn-fields, killing that which was not too far ripened; and then attacked the young wheat, cutting it off just beneath the surface of the earth, "taking all clean as they go. They are of all stages of growth, and have been from the first, and the ground is perforated with the holes made by them." 3. In common with many other grains and vegetables, young wheat is sometimes injured by the "Cut-worms," (*Agrotidudæ*,) "Wire-worms," (*Iuli*,) and "Grub-worms," (*Melolonthadæ*,) but these will be referred to more particularly hereafter.

(B,) Insects which injure the straw of wheat while growing:

1. The Chinch-bug (*Lygæus leucopterus*. SAY.) has done much severe injury in the South and West, including Wisconsin and Illinois. In its perfect state it is winged, and measures three-twentieths of an inch in length. The eggs are laid in the ground; and the young make their appearance on wheat about the middle of June, and still later attack all kinds of grain, corn, and herds-grass, during the whole summer. 2. The Joint-worm (Eurytoma———?) has proved eminently destructive in Virginia. It varies from one-tenth to nearly three-twentieths of an inch in length, is of a pale yellowish white color, with an internal dusky streak, and is destitute of hairs. It buries itself in the straw, generally at a joint, in or near the second or third joint from the ground. The substance of the straw for a distance exceeding half an inch is much swollen, and changed to a wood-like texture, while the surface exhibits long, pale spots, slightly elevated like a blister. The worm finally changes to a winged insect. Burning the stubble as soon as the grain is harvested is recommended as a cure. 3. The Hessian Fly (*Cecidomyia destructor*,) is supposed to have been introduced from

Germany into Long Island, R. I., by the Hessian troops, under Sir W. Howe, in 1776. Thence it gradually spread over the Southern parts of New York and Connecticut, at the rate of fifteen or twenty miles a year. It was found west of the Alleghany Mountains, in 1797. In many places, the culture of wheat was abandoned in consequence of its ravages. The body of the perfect insect measures about one-tenth of an inch in length, and the wings expand a quarter of an inch or more. Two broods are brought to maturity in the course of a year, and the flies appear in the spring and fall. In the latitude of New England, the female begins to lay its eggs on the blade of the young wheat at the end of September, or beginning of October. In four to fifteen days the egg hatches; the maggot, of a pale red color, crawls down the leaf, and works its way between it and the main stalk, passing down till it comes to a joint, just above which it remains, a little below the surface of the ground, with the head towards the root of the plant. Here it rests till its transformations are completed. It niether eats the stalk, nor penetrates within it, but lies lengthwise upon its surface, nourished wholly by the sap. As it increases in size, it becomes imbedded in the side of the stem, by pressure. If two or three are fixed in this manner they frequently cause the plant to fall down and die. In five or six weeks they grow to full size—three-twentieths of an inch in length. About the first of December, they harden and change to a bright chestnut color; in which form they are commonly likened to a flax seed. In this state, they gradually change to a fly, and appear again as such at the end of April or beginning of May. Very soon after, they are ready to lay their eggs on the leaves of the wheat sown in the previous fall, or the same spring. In three weeks they entirely disappear from the field. Undergoing the same changes, the maggets from these eggs take the flax-seed form in June and July. In this state they are found at the time of harvest, and when the grain is gathered they remain in the stubble in the fields. Some, however, are carried to the barn The principal migrations of the flies take place in the middle of August and September. 4. In 1843, Miss Morris discovered in Pennsylvania, another species of the Hessian Fly. (*Cecidomyia culmicola.*) It differs in its habits from the former, by depositing its eggs early in June *in the grain.* The egg remains unhatched till the grain is sown and germinates, and the maggot soon eats its way into and burries itself in the straw. Here it remains till it is ready to assume the flax-seed form, and then, emerging, fixes itself to the outside of the stalk. It has since disappeared from the locality, but may probably be met with elsewhere, being mistaken for the first species.

5. The larva or maggots of *Oscinis lineata, Chlorops pumilionis, and Chlorops glabra,* and other flies allied to them, live within the lower part of the stems of wheat, rye, and barley, thereby impoverishing the plants, and causing them to become stinted in their growth. They are rather larger insects than the *Frit-Fly.* It is highly probable that some of these species, or the *Oscinians* with similar habits may be found in the stems of wheat, and other grains, and perhaps also in the ears. "A careful examination of all the insects that inhabit our fields of grain is very much wanted." (*Harris.*)

6. The *Patent Office Report,* 1845, p. 144, mentions a worm which appeared among wheat in Buck's Co., Penn. "It is a green worm about an inch long; its head is brownish green, with two brown spots on it. It ascends the stalk of wheat, soon after it has headed, cuts off the head, and feeds upon the top of the standing part."

(*C,*) Insects which injure the grain of wheat in the field:

1. Wheat-fly, Grain-worm, Weevil, (*Cccidomayia Tritici.*) This is a small fly, one-tenth of an inch long, somewhat resembling a musquito in form, and was probably introduced from England. It is said to have been first seen in America in 1828, in North Vermont, and Lower Canada. It has since spread to Upper Canada, New York, New Hampshire, Massachusetts, Connecticut, and probably other States; and has, in some instances, caused the growth of wheat to be relinquished. The female appears from the begining of June to the end of August, in the wheat fields, in immense swarms, when they lay their eggs in the opening flowers of the grain. The eggs hatch in about eight days, and a little yellow magget is produced. It never exceeds an eight of an inch in length. From two to twenty have been found within the husk of a single grain. They prey on the wheat in its milky state, and stop when it becomes hard; in consequence, the kernels never fill out. Late in July and early in August, these maggets change their skins and enter the ground, where they remain through the winter; at the depth of an inch. Deep plowing in the fall, and the use of caustic lime as a manure are recommended for their destruction, as the best among many receipts.

2. Another small fly, very similar in its effects (*Thrips cerealium,*) has been met with in New Hampshire. 3. Brown Weevil, Grey Worm, Wheat-worm, (Caradrina cubicularis ?) This, which has proved very injurious in Western New York, Northern Pennsylvania, and other localities, has not yet been distinctly recognized as a species, nor is its

full history known. It is a catapillar or span-worm, from three to five-eighths of an inch long, of various shades of brown or yellow in color. It feeds not only on the kernel in the milky state, but also devours the germinating end of the ripened grain, without burying itself within the hull; and it is found in great numbers in the chaff when the grain is thrashed. They continue to eat the grain after harvest. Hot water should be poured on those met with in thrashing, and none should be allowed to escape.

(D,) Insects which injure grain in the granary:

1. The Grain Weevil, (*Calandra* or *Curculio granarius.*) This belongs to the same family of insects as the Curculio which destroys plums. In its perfect state it is a slender beetle of a pitchy red color, about an eighth of an inch long. The female deposites her eggs upon the wheat after it is housed, and the young grubs hatched therefrom immediately burrow into the wheat, each individual occupying alone a single grain, the substance of which it devours so as to leave nothing but the hull, and the loss of weight is the only external evidence of the mischief that has been done. The adults also eat the grain. In Europe, it has proved peculiarly destructive to stored grain. Roasting or kiln-drying the wheat, effectually destroys the grub. 2. The Grain-moth (*Tinea granella.*) 3. The Angoumois moth (*Anacampsis cerealella,*) are small moths, resembling the well known carpet-month of houses, the grubs of which prey on stored grain. They have spread very generally over the United States. The last species was probably introduced into Virginia from France

There are probably many other insects than the above injurious to wheat at various stages of its growth; but unfortunately practical farmers pay little attention to entomology, and are apt to confound not only one known species with another, but also those which are described with those which are not. An intelligent farmer would confer a great benefit on the community were he to study carefully the habits of all insects injurious to vegetation in his own locality, and make the results known. Insects injurious to the farmer appear to be increasing in all parts of this country, and it is very essential that their habits should be accurately studied so that remedies may be devised. It is only by our becoming thoroughly acquainted with the character and peculiarities of our enemies, that we can hope to overcome them. Mere guesses, and random experiments, rarely if ever, prove of any benefit. The loss annually sustained by the country in consequence of the de-

predations of insects is exceeding great, and is calculated by millions of dollars.

203. The manufacture of flour is, in itself, a business independent of the farmer. It employs a large amount of capital, requiring expensive buildings and machinery; and consumes much timber in the making of barrels. It is not necessary to refer to it any further in this place, otherwise than to say that a good farmer will always endeavor to take his wheat to market in the best and cleanest condition. In 1850, 2,202,335 barrels of Flour were exported from the United States.

It is extremely important to the practical farmer to know the cost of producing wheat, so that he may be able to make his calculations, and avoid losses. The Commissioner of Patents has more than once endeavored to acquire a knowledge of the expense of bringing a bushel of wheat to market, in various parts of the United States; and though, owing to difficulties in the way, it has been found impossible to arrive at an accurate estimate, the actual cost of every bushel of wheat, to the farmer may be stated to be from 50 cents to $1⅛ according to the location, the value of the land, and the need of manure, &c. The following, which is a *bona fide* account by a very intelligent, practical farmer, may be considered as the actual cost in the older settled parts of Michigan. The field contained 12 and 2-100 acres of land.

Plowing, 7 days, 3 pair oxen, 1 pair horses, 2 men and 1 boy,	$21,00
Harrowing 2 days with team,	2,00
Cultivating 2 days,	2,00
19½ bushels seed at $1,00,	19,50
Sowing 1 day,	63
Cultivating 3 days and harrowing 1 day,	5,00
Furrowing and cleaning furrows, 2 days,	1,50
Weeding ½ day,	31
Harvesting, &c., 37 days,	32,38
Team,	1,50
Thrashing and cleaning,	28,82
Manures,	7,75
Interest on value of land, ($6 per acre,)	7,56
	$128,95

The produce was 545 bushels of wheat or about 45 bushels per acre, making the cost about 23 cents a bushel. But if the crop had averaged 20 bushels only, which, on the average is a large crop, it would have cost nearly 54 cents a bushel. And had the crop been smaller still, say 15 bushels per acre, a fair average for the State, it would have cost over 71 cents a bushel, which is more than wheat was then selling for.

There is one apparent error in this account, and that is in the interest charged upon the land: land of such richness, drained, worked, and manured as it must be

to produce such a crop, and with its share of the necessary buildings, was at the time worth from $40 to $50 an acre, *intrinsically*. Say the smallest sum, ($40,) and the interest charged, instead of being $7,56, ought to have been $18,00 for twelve months; but it is usual to charge eighteen months interest on land employed in growing wheat, or $72,00. This would still further raise the cost of the grain, on the farm, without allowing anything for profit, or remuneration for skill, or expences of marketing. The straw, however, is generally considered an equivalent for the latter. (*L. Cone. Trans. of State Agricul. Socy. of Mich.*, 1850, *p*, 487.)

CHAPTER VII.

RYE.—(*Secale cereale.*)

204. Next to Wheat, Rye is most consumed by mankind in those latitudes which are too cold for Indian Corn. It is believed to be a native of Western or Central Asia.

M. De Candolle says that a M. Koch, who has traversed Anatolia, Armenia, the Caucasus, and Crimea, affirms that he has found Rye under circumstances where it appears to be really spontaneous and native. On the mountains of Pont, in the country of Hemschin, upon granite, at an elevation of five or six thousand feet, he found our common rye along side the road. It was thin in the ear, and about one to two and a half inches long. No one remembered that it had ever been cultivated in the neighborhood, and it was not even known as a cereal.

205. It is cultivated, to the North of Europe, in Scandinavia, on the western side of the parallel of latitude of 67° N.; and on the eastern side to latitude 65° or 66° N. In Russia, the polar limit of rye is indicated by the parallel of latitude 26° 30′. It is extensively cultivated in Europe, forming the chief part of the bread of Germany, Poland, Russia, Switzerland, and other countries. In Great Britain, and the southern countries of Europe it is little used. In America, it does no appear to be grown in Pembina, on Red River, in the Hudson Bay Territory, latitude 47° N., though wheat, barley, maize, tobacco, potatoes, &c., are cultivated with profit. It was introduced into the North American colonies soon after their settlement by the English,—into Nova Scotia, 1622; into

New England, 1648, and into South Virginia previous to that year.

206. The production of rye in the United States decreased in 1850, 4,457,000 bnshels when compared with 1840; but in New York it had been *increased* in 1850 by about 40 per cent. In 1840 the total product of the country was 18,645,567 bushels; in 1850, 14,188,639 bushels.

The chief Rye producing States are—(1850:)

	BUSHELS.		BUSHELS.
Pennsylvania, - -	4,805,160	Connecticut, - -	600,893
New York, - - -	4,148,182	Ohio, - - - -	425,718
Massachusetts, - -	481,021	Kentucky, - - -	415,073
Virginia, - - - -	458,930	New Jersey, - -	1,255,578
Michigan, - - -	105,871.		

It is grown, more or less, in all the States except California and New Mexico; but, with two exceptions, (Maryland and North Carolina,) none give over 200,000 bushels. It has been chiefly used for distilling and feeding stock, though bread is made of it in some localities. The export in 1850, was 44,152 bbls. of flour.

207. There is only one cultivated species, but several varieties: *(a,)* Common; *(b,)* Multicole; *(c,)* St. John's Day; *(d,)* Siberian; also, *(e,)* Spring, *(f,)* Winter, and *(g,)* Southern.

Of the Common *(a,)* nothing need be said. The Multicole *(many rooted,)* *(b,)* was introduced into this country by means of the Patent Office about 1844–5. It was found to produce heavy crops, and to stool out very perfectly,—ten to twenty stalks growing from every seed. It also appears to be well adapted for high northern latitudes. The St. John's Day *(c,)* is a native of the Italian Alps, and was introduced into England about ten years ago for soiling purposes. The seed is very small, dark, and hard, but the straw grows with great rapidity, to a great height, affording a remarkable quantity of green fodder. The Siberian *(d,)* is a German variety, noted for the gigantic product of grain and stalk. The grain is large with a

thin skin, yielding an excellent flour. The other varieties have arisen from the period of sowing, or climate.

The yield is from ten to thirty, or more bushels per acre, weighing from 48 to 56 lbs. per bushel. In Michigan the *legal* weight of a bushel is 56 lbs.

208. Ultimate ANALYSIS of Rye and straw: *(Boussingault.)*

	GRAIN.	STRAW.
Carbon,	46.35	49.88
Hydrogen,	5.38	5.58
Oxygen,	44.21	40.56
Nitrogen,	1.69	0.30
Ash,	2.37	3,68
	100.00	100.00

209. Inorganic analysis of the grain of Rye. The grain of Rye leaves 2.425 per cent of ash, which is thus composed:

	Will and Fresenius.	Bichon.	Mean.
Potash,	32.76	11.43	22.08
Soda,	4.45	18.89	11.67
Lime,	2.92	7.05	4.93
Magnesia,	10 13	10.57	10.35
Oxide of iron,	0.82	1.90	1.36
Phosphoric acid,	47 29	51.81	49.55
Sulphuric acid,	1.46	0.51	0.98
Silica,	0.17	0.69	0.43

210. Organic analysis of Rye, dried at 212 ° F. *(Horsford & Krocker.)*

	Rye flour from Vienna.		Rye flour from Hohenheim.	
	No. 1.	No. 2.	Schilf.	Standen.
Gluten and albumen,	11.92	18.69	17.73	15.76
Starch,	60.91	54.48	45.09	47.42
Woody fibre, gum, sugar,	24.74	24.49	35.77	35.25
Ash,	1.33	1.07	2.43	2.37
	98.90	98.73	101.02	100.80
Moisture in fresh substance,	13.78	14.68	13.94	13.82

211. It will be observed from the above, that Rye varies

much in its composition according to the soil in which it is grown. Hermbstadt experimenting with the grain as he did with wheat (§177,) found in 100 parts:

Manured with - -	Ox blood.	Sheep's dung	Goat's dung.	Human urine.	Pigeons' dung.	Human excrement.	Horse dung.	Cows' dung	Vegetable mould.	Unmanured.
Gluten and albumen, -	15.6	15.6	15.6	15.5	15.3	15.1	14.7	12.8	11.4	11.2
Starch, gum, sugar, fat, -	63.0	63.1	62.7	59.2	61.5	63.1	60.8	64 8	66.0	67.3
Increase in grain, - -	14 fold.	13 f	12½f	13 f	9 f	13½ f	11 f	9 f	6 f	4 f

212. Inorganic analysis of Rye straw. 100,000 parts of the straw, contain 2793 parts of inorganic matter. *(Sprengel.)*

Potash, - - -	32	Oxide of manganese, -	——
Soda, - - - -	11	Silica, - - -	2297
Lime, - - -	178	Sulphuric acid, - -	170
Magnesia, - - -	12	Phosphoric acid, - -	51
Alumina, Oxide of iron, } - -	25	Chlorine, - -	17
			2793

213. The flour of rye is not white like that of wheat, but has a pretty strong, grayish brown tint, and does not bind so firmly with water. It yields a short, much less tough dough, out of which it is impossible to seperate the gluten from the starch by washing with water. The cause of this is probably to be sought in some peculiarity of the gluten of rye. It contains very little fibrin, and on the contrary a nitrogenous substance, which Heldt has ascertained to be *vegetable gelatin.* The starch is of the same nature as that contained in other seeds.

214. Dombaste found that 100 parts of rye flour yielded, when baked, 145 lbs. of bread, or nearly the same quantity as is yielded by northern wheat. Johnston found rye bread, when leavened, to lose 44, when yeasted, 46 per cent. of water. 100 lbs. of flour containing naturally 16 per cent. of water, must then have yielded from 150 to 160 lbs. of bread.

215. The soils best adapted for rye are of a light, sandy

character. As wheat is the cereal of the clay, so rye is the cereal of the sandy soils. It will, however, grow well on all soils if rendered sufficiently friable, and not damp.

216. As will be observed by the analysis, (§208,) the principal inorganic constituents are Potash, Soda, Magnesia, and Phosphoric acid, but the per centage of ash is very small, rarely, if ever, above 2½ per cent. of the dry grain. Wood ashes, either unleached or leached are the most available manures.

217. Rye is sown as a winter and spring crop,—generally as the former. One plowing is given and the seed dragged in. If more care is taken in the preparation of the soil the crop will be larger. It is a custom in some localities to sow rye among standing corn, hoeing it in, and leaving the ground as level as possible. After the corn is removed, the rye is rolled. Harrowing and rolling in the spring, are recommended.

218. The time of sowing in the fall is, in the Northern States, from 20th August to 20th September. From 1¼ to two bushels of seed are sown, the richest lands demanding most. In spring it should be sown as early as the climate will permit.

219. In other respects, the culture, harvesting, &c., resemble those of wheat.

220. If cut before fully ripe, the grain makes better flour, and in larger quantity; but if intended for seed it should be fully ripened.

221. In some countries, rye and wheat are sown together. In England this mixture is called *Mesling*, *Mescelin*, or *Maslin*, (from an old French word *mester*, to mingle.)

222. Rye is frequently sown for fodder, being either pastured during the winter and spring, or cut green for soiling stock in stables. It affords a large amount of valuable food, and the crop of grain is improved by pasturing to a certain point.

223. It is also employed to plow in as a green manure. In the lighter class of wheat soils, it is recommended, after harvesting the wheat, to plow, and sow rye as early as possible; pasture with sheep and young stock through the winter, and then plow in for a spring crop. This system, alternated with two or more years of grass or clover, will rapidly restore unpoverished soils. For this purpose the Multicole, and *probably* St. John's Day variety are the best, but we are not aware that the latter has yet been tried in the United States.

224. There are no weeds peculiar to rye; but those which are troublesome to wheat will generally be found among this grain, according to the season in which it is sown.

225. The only parasitic fungus affecting rye is ERGOT *(Sclerotium clavis.)*

Ergot is a kind of spur which issues from the grain of rye. It is not a fungus itself, but a morbid growth caused by the existence of minute fungi in the grain. It is not confined to rye alone, but has been observed occasionally in wheat and barley, and some of the grasses. It is a poison when eaten in bread, producing a spontaneous gangrene, called *ergotism.* It is also a powerful medicine, for which purpose it was first used in the United States, in 1807. The composition of the ash of ergot is as follows: (*Engelmann.*)

Potash,	45.38	Sulphuric acid,	0.02
Soda,	16.79	Chlorine,	2.36
Lime,	1.68	Silica,	15.60
Magnesia,	5.34		
Oxide of iron,	2.34		104.95
Phosphoric acid,	15.44		
Per centage of Ash,			0.36

It is chiefly found where rye grows in damp adhesive soils. Animals should not be allowed to eat it; as some will do when it is mixed with grain.

226. There are no insects peculiar to this cereal.

227. The straw, owing to its length and stiffness, is useful for many economical purposes, but not as good for feeding stock as some other sorts, unless cut and bruised.

227* Petri gives an experiment made to ascertain the proper depth for planting rye, as follows:

Depth of seed,	Appeared above ground in	No. of plants that came up.
$\frac{1}{2}$ inch.	11 days.	$\frac{7}{8}$ths.
1 "	12 "	all.
2 inches.	18 "	$\frac{7}{8}$ths.
3 "	20 "	$\frac{3}{4}$ths.
4 "	21 "	$\frac{1}{2}$
5 "	22 "	$\frac{3}{8}$ths.
6 "	23 "	$\frac{1}{8}$th.

The root stalk forms itself always next below the surface of the ground; and if we place the grain deep, it must first put out its sprouts to the surface, and form its side branches in a nearer connection with the air. We never find that the sucker-roots are arranged from below to above, but the contrary.

CHAPTER VIII.

BARLEY.—*(Hordeum.)*

228. The native country is unknown.

229. Barley is cultivated further north than any other of the grains. In Europe, its northern limits are as follows:

Orkney and Shetland Islands, -	Lat. 61° N.
Faroe Islands, - - - -	" 61° to 61° 15′ N.
Western Lapland, - - -	" 70° N.
Russia (White Sea,) - - -	" 67° to 68° N.
Archangel, - - -	" 66° N.
Central Siberia, - - - -	" 58° to 59° N.

It cannot be grown in Iceland, lat. 63° 30′ to 66° N.

In summer mean temperature, the northern limit varies between 46° 4′ and 49° F., in the latter being injured by rains. Its northern limit, in America, does not appear to have been ascertained.

230. It is cultivated in the four quarters of the globe: in Syria and Egypt for more than 3,000 years.

231. It was introduced into the United States by Gosnold in 1602, and by colonists into Virginia in 1611. By the year 1648, it was raised in abundance in that colony, but it afterwards diminished in quantity.

The annual amount of Barley grown in United States was, in 1840, 4,161,504 bushels; in 1850, 5,167,016 bushels. The principal States that produce it are, (1850:)

	BUSHELS.		BUSHELS.
New York, -	3,585,059	Pennsylvania, -	165,584
Ohio, - -	354,358	Maine, - -	151,731
Wisconsin, -	209,692	Massachusetts, -	112,385
Michigan, - - - -	75,249		

All the other States, except Florida, Louisiana, and Oregon, raise more or less, though four of them did not produce a thousand bushels each in 1850. There is little or none exported. It is chiefly consumed in the manufacture of malt and spiritous liquors, while some is fed to hogs and o.her stock.

232. Six species or varieties are cultivated:

1. *Hordeum distichum.*—Two-rowed Barley.
2. " *gymno-distichum.*—Two-rowed naked Barley.
3. " *disticho-zeocriton.*—Two-rowed Sprat, or Battledore Barley.
4. " *hexastichum.*—Six-rowed Barley.
5. " *gymno-hexasticum.*—Six-rowed naked Barley.
6. " *hexasticho-zeocriton.*—Six-rowed Sprat, or Battledore Barley.

Of these again, there are some thirty sub-varieties, such as the *Chevalier Barley;* the *Hudson's Bay*, &c.

The two-rowed variety is most commonly cultivated. The sub-varieties are distinguished by the quality of their grain, their period of ripening, and productiveness. In mild climates barley is sown, like wheat, in the fall, and is known as winter-barley. Occasionally the color of the corolla is black. In the *naked* barley, the corolla is not attached to the grain, and it thus resembles wheat. It was introduced into England in 1768, and is known in the United States, but in neither country does it appear to be much cultivated. The *Sprat* Barley has the spike short and conical, the awns long and spreading, and the seeds more compressed than in the first sort. The straw, also, is very short. It is little cultivated. In *six-rowed* Barley, three rows of flowers on each side of the spike are fertile, and consequently three rows of grains on each side are

perfected. The chief sub-variety of this is known as *Bere* or *Bigg*. It is more hardy and productive then the two-rowed, and is used for fall sowing. In Europe it is much cultivated; in the United States but little. The yield of Barley is from twenty to sixty bushels per acre, weighing from 45 to 55 lbs. per bushel according to variety. In Michigan the legal weight of a bushel is 48 lbs.

233. Ultimate ANALYSIS of Barley, dry (A,) and with water, (B.) *(Thompson.)*

	A	B
Carbon,	46.11	41.64
Hydrogen,	6.65	0.02
Nitrogen,	1.91	1.81
Oxygen,	42.24	38.28
Ash,	3.09	2.79
Water,		9.46
	100.00	100.00

233. Inorganic analysis of Barley. *(Thompson.)*

Silica,	29.67
Phosphoric acid,	36.80
Sulphuric acid,	0.16
Chlorine,	0.15
Peroxide of iron,	0.83
Lime,	3.23
Magnesia,	4.30
Potash,	16.00
Soda,	8.86

Mean of ten analyses of Barley grain, *(Way & Ogsden,)* from calcareous soils, Dorset, England:

Ashes in 100 parts, in crop as taken from the ground,	2.34
Ashes in artificially dried plants,	2.43
Potash,	19.77
Soda,	3.93
Magnesia,	8.55
Lime,	2.58
Phosphoric acid,	35.20

Sulphuric acid, - - - - - -	1.03
Silica, - - - - - - - -	26.49
Peroxide of iron, - - - - - - -	1.43
Chloride of sodium, - - - - - -	0.47

In some specimens the chloride of sodium amounted to 1.01, and chloride of potassium to 5.65 per cent.

235. Organic analysis of Barley dried at 212 ° F. *(Krocker and Horsford, and Thompson.)*

	Winter Barley Hohenheim.	Jerusalem Barley Hohenheim	Scotch Barley Scotland.
Gluten and albumen, -	17.70	14.72	15.24
Starch, - - - - -	38.31	42.34	39.86
Husk, Gum, Sugar, -	42.33	42.46	46 19
Ash. - - - -	5 52	2.84	3.26
Moisture in the first grain,	13.80	16.79	12.71

236. Barley has been less perfectly examined than any of the other cereals, except oats, and the nature of the gluten contained in them is totally unknown. All that can be said with certainty upon this point is confined to the observation that the gluten of these two grains is mechanically separated with much greater difficulty than that of either wheat or rye; that by the agency of some other substance in the flour, it is almost wholly dissolved in water, and is much less abundant than in either of the other two. It is also probable that it contains but little fibrin, and resembles in this respect the gluten of rye. *(Knapp.)*

237. Hermbstadt, in experimenting with Barley, found that the action of nitrogenous manures tends rather to increase the crop than to the production of gluten.

238. According to Proust, the greater part of the non-nitrogenous constituent in Barley is not starch, although a substance similar to it, but insoluble in boiling water, which he called *hordein*.

239. Analysis of Barley straw, (A,) *(Fresenius)* and awn, (B.) *(Way.)*

	A	B
Sand and Silica,	43.8	70.8
Potash.	21.0	7.7
Soda,	0.8	0.4
Lime,	7.2	10.4
Magnesia,	3.3	1.3
Oxide of iron,	0.2?	1.4
Chloride of Potassium, Chloride of Sodium,	8.9	1.1
Phosphoric acid,	3.1	2.0
Sulphuric acid,	11.7	3.0
Carbonic acid,	——	2.0

240. The value of Barley depends much on the relative hardness of its husk, and this appears to be influenced by soil and manure in its culture. A soft thin skin adapts it better for malting, and a light chalk soil is best suited to produce it of this character. Fromberg has ascertained that the hard Barley contains less gluten and albumen than the softer kinds: thus be found:

	Water.	Nitrogen equal to gluten, &c.
Soft or malting Barley to contain pr. ct.,	13.55	10.93
Flinty or Pot Barley,	13.4	8.03

The effect of soil upon the Barley crop is known to all practical farmers—so that, in Great Britain, the terms barley-land and wheat-land are the usual designations for light and heavy soils. On clay lands the produce of barley is greater, but it is of a coarser quality and does not malt so well,—on loams it is plump and full of meal, and on light chalk soils the crop is light, but the grain is thin in the skin and of a rich color, and well adapted for malting. *(Johnston.)*

241. *Malt* is Barley which has been made to germinate by moisture and warmth, and afterwards dried, by which the vitality of the seed is destroyed. By this process, a peculiar nitrogenous principle, called *diastase*, is produced. This, though it does not constitute more than 1-500th part of the malt, serves

to affect the conversion of the starch of the seed into dextrine and grape sugar. 100 lbs. of barley yield about 80 lbs. of malt, part of which difference is the loss of the water previously contained in the barley. Thompson gives the following comparative table of barley; and malt made from the same grain; showing the change which takes place in the organic constituents:

	BARLEY.	MALT.
Carbon - - - - - -	41.64	33.95
Hydrogen - - - - - -	6.02	5.31
Nitrogen - - - - - -	1.81	0.88
Oxygen - - - - - -	37.66	34.46
Ash - - - - - - -	3.41	1.34
Water - - - - - - -	9.46	4.06
	100.00	80.00

Or the loss sustained by barley in malting may be stated as follows:

Water, - - - - - -	6.00	per cent.
Saline matter, - - - - - -	0.48	"
Organic matter, - - - - - -	12.52	"

242. Barley is rarely or never used in America and Great Britain as bread, but it is eaten in soups and given to the sick as *Pot* and *Pearl Barley*, in which condition it is considered very nourishing. This form is produced, by rubbing the grains in an appropriate machine, till they are deprived of the husk and outer coats, and become spherical. Such barley is generally imported into the United States from Scotland, but there is no reason why it should not be prepared here. A porridge made of barley meal is used in Scotland.

243. The quantities of mineral matter removed from the acre by a crop of 40 Imperial Bushels of Barley, and 2650 lbs. of straw are as follows:

	By the Grain.	By the Straw.	TOTAL.
Potash - - -	7.24 lbs.	10.29 lbs.	17.53 lbs.
Soda - - - -	4.32 "	0.92 "	5.24 "
Magnesia - - -	3.97 "	5.25 "	9.22 "
Phosphoric acid - -	20.74 "	5.02 "	25.76 "
Sulphuric acid - -	0.05 "	2.66 "	2.71 "
Chlorine - - -	0.02 "	1.58 "	1.60 "
	36.34 lbs.	25.72 lbs.	62.06 lbs.

244. As has been already observed, Barley succeeds best on lands more sandy and lighter than those adapted for wheat, yet containing a good proportion of calcareous matter. In the United States it is always sown in the spring; and in the Northern States, the earlier it is in the ground the better, so that it may have a long period of growth. Unless the soil is very light, it is well to plow in the fall, and again in the spring, and to render the earth mellow by the use of the cultivator and harrow before sowing. For a good crop the land should be rendered rich by previous manuring; but barn-yard manure applied directly to the crop is supposed to be injurious. From two to three bushels of seed are generally sown to the acre; and the land should be rolled immediately, or, which is perhaps preferable, as soon as the young plant is from one to two inches high. The productiveness of barley appears to depend much upon rolling. Judge Buel, of Albany, N. Y., recommends steeping the seed in a weak solution of Saltpetre *(Nitrate of Potash or Soda,)* for twenty-four hours; and some use the black water which collects in barn-yards around manure-heaps for the same purpose.

245. Barley is known to be ripe by the disappearance of the reddish hue on the ear; and by the ears beginning to droop against the stem. Unless intended for seed, it should be cut before it is fully ripe, both on account of the better quality and weight of the grain, and to prevent waste by shelling.

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246. Harvesting of barley is the same as of other grains, except that it sometimes happens that the straw is too short for cradling, when it may be mowed and raked into bundles to dry.

247. The straw is used for fodder and litter, but for the former purpose is not so good as wheat and oat straw.

248. It is the best grain with which to sow grass and clover seed.

249. There are no weeds peculiar to this crop.

250. The only parasitic fungus which usually attacks barley is the smut *("Black Heads,") Uredo segetum*, (§197, *c*,) but in some parts of the United States this has proved very injurious, especially on the six-rowed varieties.

251. In New England, barley has, at times, suffered severely from the Joint-worm *(Eurytoma,)* (§201, *b*, 2.) Other insects may probably injure the crop, but they do not appear to have been described.

CHAPTER IX.

OATS.—*Avena.*

252. The Oat is supposed to be a native of Asia. A species is found wild in California.

253. The Northern limits of this grain in Europe appear to be in

Scotland, - - - -	Lat. 58° 40′ N.
Norway, - - - -	Lat. 56° "
Sweden, - - - -	Lat. 63° 30′ "
Russia, - - - -	Lat. 62° 30′ "

It is extensively cultivated in the Northern, but not in the Southern parts of Europe. It grows well in Bengal, India, lat. 25° N. In America it is cultivated as far as settlements extend Northwards. It was introduced into the United States at the same time as Rye. In this country it is confined principally to the middle, western, and northern States. Its profitable production would appear to depend much on the frequency of rain during its growth.

254. The total produce of the United States in 1840 was 123,071,341 bushels, in 1850, 146,678,879 bushels.

The chief oat-producing States are (1850:)

New York, -	26.552,814 bush.	Illinois, - -	10,087,241 bush.
Pennsylvania, -	21,538,156 "	Kentucky, - -	8,201,311 "
Ohio, - -	13,,472,742 "	Tennessee, -	7,703,086 "
Virginia, - -	10,179,045 "	Missouri, - -	5,278,079 "
Michigan, -	2,866,056 bush.		

All the other States produce more or less,—fifteen of them from one to four millions of bushels. With the exception of

about 60,000 bushels used in making liquors, the whole is consumed in feeding stock. There is scarcely any exported.

255. Five species are cultivated:

1. *Avena strigosa.*—Bristle-pointed Oat.
2. *Avena brevis.*—Short Oat.
3. *Avena sativa.*—Common Oat.
4. *Avena orientalis.*—Tartarian Oat.
5. *Avena nuda.*—Naked Oat.

These again are divided into many varieties.

The first two are of inferior quality, but hardy, being cultivated in the mountainous parts, the one of Scotland, the other of France. The *common oat* is best known, and has been much improved by careful culture. The *Tartarian oat*, has its panicles shorter than the last, nearly of equal length, all on the same side of the rachis *(flower stalk)* and bearded. It is so hardy as to thrive in soils and climates where the other grains cannot be raised. It is much cultivated in England and not at all in Scotland. "It is a coarse grain more fit for horse feed than to make into meal." *(Stephens.)* The corolla is frequently black. The *naked oat*, like wheat and naked barley, has the corolla detached from the seed. It has long been cultivated in Europe, and it is said to be productive, and the meal to be fine. The popular varieties such as the Potato, Hopetown, Georgian, Siberian, Dyock oats, &c., belong to the *common oat.* (3)

256. In Scotland the oat yields very large crops, from 36 to 114 bushels per English acre. In the United States, the crop probably does not much exceed 30 bushels per acre, except in very favorable localities; but 90 bushels per acre have been raised, and prize crops of 60 to 75 bushels are not uncommon. The soil and climate of Michigan are not favorable to it. The weight, per bushel, varies from 30 to 48 lbs., according to variety and culture. In Michigan, the legal weight of a bushel is 32 lbs.

Stephens says that in Scotland:

The potato oat, weighing 47 lbs. per bushel, gives 806,144 grains per bushel.

The Siberian early oat, weighing 46 lbs. per bushel, gives 641,792 grains per bushel.

White Tartarian oat, weighing 42 lbs. per bushel, gives 731,136 grains per bushel.

257. Ultimate ANALYSIS of the grain (A,) and straw (B,) of oats *(Boussingault.)* One part of dried oats leaves 0.0398 of ash: one part of straw leaves 0.0509 of ash.

	A	B
Carbon, - - - -	51.09	50.25
Hydrogen, - - - - -	6.44	5.48
Oxygen, - - - -	36.25	38.80
Nitrogen, - - - - -	2.24	0.38
Ash, - - - -	3 98	5.09
	100.00	100.00

258. Inorganic analysis of oat grain. *(Way & Ogsden, and Norton.)*

	Hopetown Oats.	Potato Oats.	Poland Oats.	Potato Oats without husk.	Hopetown Oats without husk.	Mean of 7 analyses of Oat Grain.	Mean of 2 analyses of Oats without husk.	Mean of 4 analyses of Oat Husks.
Achesin 100 partsin crop as taken from ground	2.27	2.45	2.65	2.22	2.14	2:90	2.18	6.79
Ashes in artificially dried plants,	2.50	2.73	2.97	—	—	3.02	—	—
Potash - - -	17.80	19.70	24.30	21.22	31.15	16.76	26.18	8.13
Soda - - - -	3.84	1.35	5.51	—	—	2.49	—	—
Magnesia - - -	7.33	8.25	8.26	11.26	8.64	7.70	9.95	1.69
Lime - - -	3 54	1.31	2.65	6.69	5.21	3.92	5.95	3.15
Phosphoric acid - -	26.46	18.87	14.49	38.48	49.19	18.19	43.84	1.54
Sulphuric acid -	1.10	0.10	1.74	18.36	2.54	1.29	10.45	6.46
Silica - - -	38.48	50.03	41.86	3.60	1.73	47.08	2 67	76.16
Peroxide of iron -	0.49	0.27	0.69	—	0.80	0.64	0.40	1.33
Chloride of sodium -	0.92	0.07	0.45	—	—	0.20	—	—
Chloride of potassium -	—	—	—	—	—	0.14	—	—

259. Inorganic analysis of oat straw, *(Mean of Levi and Boussingault.)*

Potash, - - - - -	19.14
Soda, - - - - - -	9.69
Lime, - - - - -	8.07
Magnesia, - - - - - -	3.78
Oxide of iron, - - - -	1.83
Phosphoric acid, - - - - -	2.56
Sulphuric acid, - - - - -	3.26
Chlorine, - - - - - -	3.25
Silica, - - - - - -	48.42
	100.00

The nutritive matter afforded by an acre of oat straw weighing 2700 lbs. is, of husk or woody fibre 1210 lbs.; of starch, sugar, &c., 950 lbs.; of gluten, &c., 36 lbs.; of oil or fat, and of saline matter 175 lbs. *(Stephens.)*

260. Organic analysis of four varieties of Scotch oats, *(Norton and Fromberg,)* viz: Hopetown oats, *Northumberland*, (A,) Hopetown oats, *Ayshire*, (B,) Hopetown oats *Ayrshire* (C,) Potato oats, *Northumberland* (D.)

	A.	B.	C.	D.
Starch - -	65.24	64.80	64.79	65.60
Sugar - -	4.51	2.58	2.09	0.80
Gum - - -	2.10	2.41	2.12	2.28
Oil - -	5.44	6.97	6.41	7.38
Avenin, } nitrogenous compounds,	15.76	16.26	17.72	16.29
Albumen } nitrogenous compounds,	0.46	1.29	1.76	2.17
Gluten, } nitrogenous compounds,	2.47	1.46	1.33	1.45
Epidermis (or skin) -	1.18	2.39	2.84	2.28
Alkaline salts and loss,	2.84	1.84	0.94	1.75
	100.00	100.00	100.00	100.00

From these analysis it appears that the oat is very rich in oily matters and flesh-forming compounds.

Avenin is a substance resembling ***casein*** (or ***cheese*** when chemically pure) precipitated by acetic acid from the aqueous solution of oat meal. It appears to differ but slightly from ***albumen*** in its ultimate composition; and in its utility, as food, it is probably rather more nourishing.

261. The proportions of nitrogen and protein (*flesh-forming*) com-

pounds in nine specimens of oats have been determined as follows: (*Norton.*)

	Hopetown oats			Potato oats		Oats from Wigtonshire, Scotl'd			Oats from N. Y.
Nitrogen,	2.13	2.35	2.28	2.76	2.82	2 89	5.51	2.49	3 00
Protein compounds,	14.0	14.78	14.04	17.36	17.77	18.24	22.01	15.66	18 86

The relative proportions of nitrogen and protein compounds in the husk, (A,) grain (B,) and whole oat (C,) are as follows:

	A	B	C
Nitrogen,	0.30	2 82	2.18
Protein compounds,	1.88	17.77	13.72

The mean of eight samples of Scotch oats gave Mr. Norton

Grain,	76.28
Husk,	23.68

The maximum of husk being 28.2, and the minimum 22.0. Fresh oats contain from 16 to 21 per cent of water.

The organic composition of the Husk is:

	Hopetown Oat.	Potato Oat.
Oil,	1.50	0.92
Sugar and gum,	0.47	0.75
Gluten and coagulated albumen,	1.88	1.88
Cellulose,	89.68	89.46
Saline matter, (ash,)	6.47	6.99

262. Animal manures increase the crop and weight of the husk rather than the proportion of gluten.

263. In America, oats are used solely for feeding animals, and for this purpose they are equal to any other grain; combining the largest amount of useful qualities. For horses doing hard work, or where great speed is required nothing can replace them; and as the proportion of oil which they contain is but little inferior to that in Indian corn, while it is probably more readily digested and received into the system, they are used with great advantage for fattening hogs and other stock. For this purpose, however, owing to the hard husk, they ought to be crushed, and are preferable if boiled.

Where crushing or grinding cannot be effected, boiling serves nearly as good a purpose.

The peculiar form of the *casein* or *avenin* appears to give oats a nourishing power little inferior to that of animal food.

In Ireland, Scotland, and other countries, oat meal constitutes almost the entire food of the majority of the people; and those who live on it are not only physically perfect, but are able to undergo great exertion. and bear up against severe exposure and hardship. Owing to the small proportion of gluten, yeast-bread cannot be made with oat meal as with wheat flour, and it is usually eaten boiled, or made into thin cakes, dried in the air. Before grinding, it is necessary to kiln-dry oats; and they are ground in a mill constructed for the purpose, the mill-stones being different from those used in flouring mills.

264. Oats will grow upon almost any kind of soil, but the clays, and loams that are sufficiently retentive of moisture are the most favorable.

Owing to this facility of cultivation less pains are frequently bestowed upon this crop than upon others; though it will well repay proper culture.

There is a prevalent notion that oats particularly exhaust the soil on which they are grown, but we believe it to be a mistake. The form of the roots, however, predisposes the soil to collect in clods, and hard lumps, which are afterwards broken with difficulty, and unless these are carefully disintegrated, they may probably affect the succeeding crop injuriously. Barley, on the contrary, seperates the soil, rendering it mellow with its roots. As a mechanical agent, therefore, the roots of the oat plant may act unfavorably. The different varieties, containing such different proportions of organic constituents, are adapted to different soils and circumstances.

265. A crop of 50 bushels of oats, and 3800 lbs. of straw takes from the acre of soil the following quantities :

	By the grain.	By the straw.	Total.
Potash and soda, - -	10.88 lbs.	64.78 lbs.	75.66 lbs
Magnesia, - -	3.52 "	8.95 "	12.47 "
Phosphoric acid, -	14.48 "	5.38 "	19.86 "
Sulphuric acid, - -	5.28 "	9.95 "	15.23 "
Chlorine, - -	0.35 "	8.51 "	8.86 "
	34.51 lbs.	97.57 lbs.	132.08 lbs.

(*Stephens.*)

266. In the northern States, oats are always sown in spring, from the commencement of vegetation to the begining of June. They are a favorite crop to sow upon plowed sod. The quantity of seed varies from two to four bushels an acre; in Scotland six bushels are sown; under most circumstances, the larger quantity is preferable. The seed should be well harrowed in and rolled.

267. The best time for harvesting is before the grain is quite ripe, and while the straw is partially green. Oats may be cut with a sickle, cradle, scythe, or machine; but should be left for a few days in swath, before binding, when the grain will mature. Oats thus cut before they are quite ripe are larger, and heavier, while the straw, as fodder, is more nutritious. Oats, cut as above, do not appear to be inferior in any respect. (§312.)

268. Oat straw is more esteemed for fodder than that of wheat, barley, or rye. According to experiments made in Germany by Viet, 200 lbs. of oat straw with the chaff are equivalent to 100 lbs. of good hay, though, for the United States, this estimate is probably too low. If not too ripe when cut, and if saved in good condition, cattle in stables can be kept during winter in improving condition upon this straw alone. Late experiments in Scotland have proved oat-straw to be fully equal to hay for animals fattening on roots.

169. In this country, there is no insect peculiarly injurious to oats. In common with other grains, it occasionally suffers from the Wire worm.

270. Smut *(Black heads,) (Uredo Segetum,)* appears to be the only fungus to which it is generally subject, and this, rarely, to any great extent.

271. There are no weeds peculiar to this crop.

In soils where Wild Mustard *(Sinapis arvensis,)* and Wild Radish *(Raphanus raphanistrum,)* are abundant, oats are perhaps more seri-

ously injured than any other grain. As many persons are ignorant how to root out these weeds, it may be well to copy the following rules by a late French writer in the *Annales de l'agriculture*, who had been entirely successful in clearing a farm overrun with them.

1. Plow *very* deep, so as to give all the seeds within reach of the plow facilities for germinating.

2. Harrow the ground till every clod is broken, for the seeds are often retained in clods, and only germinate when these are disintegrated by rain, &c., or by artificial means.

3. Cultivate two hoed crops before grain is sown, and do not allow a single plant of mustard to go to seed.

4. For the third crop, grow oats, *drilled* at a sufficient distance to permit hand hoeing between the rows.

By using these means, and not allowing a single plant to seed, the worst fields may be cleared in three or four years. It is important that the first plowing should be deeper than any succeeding one, as the soil frequently contains the seeds to a great depth, which will germinate as soon as exposed to the air.

Of course it is requisite that all grain sown should be *quite* free from the seeds of the mustard.

272. Common salt, from four to eight bushels per acre—spread three or four days before the seed is sown, and lightly harrowed in, has been found an useful manure for oats, especially at a distance from the sea. It supplies the soda, chlorine, and magnesia; it retains moisture in the soil; it acts as a solvent on the other constituents of the earth; and generally strengthens the straw. We warmly recommend a trial of it in those parts of Michigan where the oat crop is apt to fail. Wood ashes also (uncleached) are a valuable manure, especially in sandy soils, for oats.

CHAPTER X.

INDIAN CORN.—MAIZE.—*Zea Mays.*

273. The origin of the word "Maize" is from the Haytien *mahiz.* This grain is a native of the American continent, and was unknown to the rest of the world till the discoveries of Columbus. It is still found growing wild from the Rocky Mountains to Paraguay, but in this state, instead of having each grain naked, it is completely covered with glumes or husks. A variety of the wild corn has been cultivated of late years in the northern States, under the name of "Texas corn." This grain was found by the first European explorers of the continent to be everywhere cultivated by the natives.

Only one species has usually been recognized in this country, but the late M. Bonafous, director of the Royal Agricultural Garden of Turin, in his *Histoire naturelle agricole et economique du Mais,* describes four distinct species, viz :

1. Zea Mays—with leaves entire.
2. Zea caragua, with leaves denticulated.
3. Zea hirta, with hairy leaves.
4. Zea erythrolepis, with grains compressed, and red glumes—(husks.)

From these, but especially the first, all the varieties at present cultivated have sprung.

274. It has a wide range of temperature in America, flourishing from about 40° of Southern to beyond the 45° of Northern latitude. In Mexico its highest limits vary from 2000 to 8000 feet above the level of the sea; and the time necessary for it to ripen differs from six weeks to seven months, ac-

cording to the mean temperature. In Europe, it is grown from the shores of the Mediterranean as far north as the Netherlands. The region of cultivation appears to be gradually extending further north; probably by the origin of new and hardy varieties. It is also grown in Northern, Southern, and Western Africa, India, China, Japan, Australia, the Sandwich Islands, the Azores, the Madeiras, the Canaries, and numerous other ocean islands. With the exception of Rice, it is the food of a larger number of human beings than any other grain.

275. In the United States, it was first cultivated by the English on James River, Virginia, 1608; the Indian mode being closely followed. Since then it has been everywhere a favorite crop, and annually a larger quantity is produced. The increase from 1840 to 1850 was 214,000,000 bushels, equal to 56 per cent. over the former period. In New England it has increased nearly 50 per cent.; and no State has retrograded.

The following is the production of the most important States according to the census of 1840 and 1850:

New York,	10,972,286	17,858,400
Pennsylvania,	14,240,022	19,835,214
Maryland,	8,233,086	11,104,631
Virginia,	34,577,591	35,254,319
North Carolina,	23,893,763	27,941,051
Georgia,	20,905,122	30,080,099
Alabama,	20,947,004	28,754,048
Mississippi,	13,161,237	22,446,552
Tennessee,	44,986,188	52,276,223
Kentucky,	39,847,120	58,675,591
Ohio,	33,668,144	59,078,695
Indiana,	28,155,887	52,964,363
Illinois,	22,634,211	57,646,984
Missouri,	17,332,524	36,214,537
Michigan,	2,277,039	5,641,420

Total production of the United States in 1850, 592,326,612, bushels, which at the low average of ten cents per bushel on the farm, gives an annual return of $59,232,661 in this one crop alone. The corn crop, however, represents not only the vegetable food of man, but also animal food in the shape of

pork and beef; and also various manufactures, such as oil, stearine, bristles, Prussian Blue, &c.; and large quantities of valuable manure, in the shape of refuse and offal, In one or other of these forms, a large amount of corn is annually exported to foreign countries; and the industry of the United States greatly depends upon it. The same evils, however, which attached to the growth of the potato in Ireland, may, it is feared, hereafter follow the great production of corn in those States where it is most easily raised.

276. The varieties are very numerous, depending upon the character of the soil and climate, from the small shrubby corn of Northern Canada to the gigantic stalks of the Southern States; and the composition and nutritive qualities of the grain vary in like proportion. In practice this is a very important fact, as the nutritive value of corn is constantly varying according to circumstances.

(*A.*) The Phosphates differ in quantity according to variety. *Sweet Corn* appears to contain the most. Dr. Jackson analyzed two grains of corn (the Tuscarora and Sweet Corn) grown on the *same ear*, and he found nearly double the amount of phosphates in the latter, showing that even when mixed, so as to grow on the same plant, each variety retains its power of selecting its appropriate quantity of inorganic salts. A crop of Sweet Corn will take twice as much of the phosphates from the soil as the other variety, but at the same time will give more material to the animal for the formation of bone. On the same principle the stiffness of the joints and lameness of the feet common in horses fed too freely with corn may be explained, these affections arising from an unnatural growth of bone procured from the corn.

(*B.*) The proportion of Starch changes according to the variety and climate. Southern Corn contains more than Northern. Tuscarora contains the most of any variety examined. Rice Corn, and Pop Corn contain the least.

(*C.*) The relative proportions of oil and gluten also vary in the same manner. Rice Corn contains the most oil; Pop Corn, Canada Corn, and Brown Corn rank next. Burden Corn has a very fine white oil,

Tuscarora Corn does not contain either oil or gluten.* There is a difference also in the mode of distribution of the oily and glutinous parts of corn; the Southern and Dent varieties having the oil and gluten on the sides of the elongated seed, while the starch projects quite through the grain to its summit, and by its contraction in drying, produces the peculiar pit or depression in this variety of grain. Popping Corn contains the oil in little six-sided cells in the horny portions of the grain, in the form of minute drops. When heated, the oil is decomposed into carburetted hydrogen gas, and every cell is ruptured, the grain being completely voluted.

(*D.*) The meal of those varieties containing much oil is less liable to ferment and become sour.

(*E.*) The colors depend upon that of the hull and of the oil; the latter, when yellow showing its color through a transparent epidermis (or *skin.*) The color of the oil varies much in different varieties. Red and blue corn owe their hues to the colors of the epidermis.

(*F.*) The oil appears to reside chiefly immediately under the hull, so that when animals do not digest the outer coating of the grain, as is the case when corn is fed unground to hogs, much of the oil is lost.

(*G.*) The inorganic salts, and especially the phosphates appear to be confined to the chit and germ. (*Jackson.*)

(*H.*) The large eight-rowed yellow corn contains 13.9 per cent. of albumen, casein, and gluten, while the Sioux contains 16.5 per cent. of the same.

The eight-rowed Squaw Corn contains 60.6 per cent. of starch, sugar, oil, and gum, while the eight-rowed small white Flint contains 76.6 per cent of the same. If the Squaw Corn is worth fifty cents a bushel for fattening, the Flint would be equally cheap at fifty-eight cents a bushel. (*Gould.*)

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*There are apparently two sorts of corn known as the "Tuscarora" the one mentioned above as devoid of oil, if the analysis is correct, and one analyzed by Dr. Salisbury (known also as "Turkey Wheat,") which contains 5.32 per cent. of oil, calculated without the water. What we ourselves have grown as "Tuscorora," was a peculiarly dry, starchy grain, with a thin skin, apparently deficient in oil. We would here refer the reader to the admirable Essay on Corn by Dr. Salisbury, containing the most complete and accurate examination of this grain perhaps ever made, in the *Transactions of the New York State Agricultural Society, vol. viii*, 1848. It occupies 199 closely printed octavo pages; and we would willingly have extracted more from it had our limits permitted. As these volumes, however, are not difficult to meet with, we prefer referring the reader to the Essay itself, as any quotations must prove deficient without the context.

From these facts it will be perceived how important it is that the farmer should study the adaptation of variety to the purpose intended in consumption. If he wishes to give young animals large bones, let him feed them on Sweet Corn; but at the same time manure the soil with dissolved bones, or other phosphate-bearing manures. He would endeavor in vain to fatten animals with the Tuscarora, as it contains no oil, while it makes the best bread, and is peculiarly adapted for the manufacture of corn starch. Again, the hard northern gluten-bearing corns are better for working animals than the southern-starch bearing varieties, though the latter, independent of the oil, will make most fat, the former most flesh. An accurate analysis of all varieties grown in the United States would be of great pecuniary value to the country.

277. The varieties of corn are generally distinguished by *(a,)* the number of rows of grain in the ear, as eight, twelve, fourteen, and sixteen-rowed; or by *(b,)* the color, as white, yellow, brown, &c., but none of the common divisions are either accurate or scientific. It were useless to recite the names of the many varieties, the more especially as they are constantly changing by hybridizing. It may be noticed that northern corn will improve, if removed southwards, in size and productiveness, but southern corn taken to the north will either not ripen at all, or soon degenerate.

The origin of *Sweet Corn* is unknown, but it appears to have been used by the Indians of New England before the arrival of the Pilgrims. It appears like an unripe grain; and contains an unusually large proportion of the Phosphates, and a large quantity of sugar and gum with but little starch; while the stalks, being small, take up a less proportion of the saline matters of the soil.

278. The qualities desirable in a good variety differ according to the soil and climate. In the Central and Southern States the following may be laid down as peculiarities to be attained: *(a,)* good growth of stalk and leaf; *(b,)* several ears

on each stalk; *(c,)* cob small, but long, and grains long and numerous; *(d,)* husk thick and hard so as to shed water, and resist the attacks of birds; *(e,)* ripening sufficiently early to escape early frosts. In the Northeastern States, corn with a short light stalk, but with suckers, or supernumerary stalks bearing ears, as in the Dutton, is preferred.

279. The weight of a bushel of corn greatly varies. The legal weight in Michigan is 56 lbs. to the bushel. It is stated that corn on the cob loses 20 to 50 per cent. in *measure* by shrinkage in seven months, and 10 to 15 per cent. in weight. When sold on the cob by the bushel, 2 to 1½ bushels of ears are equivalent to one bushel of shelled corn according to variety. In the Southern States it is frequently measured by the barrel of five bushels.

280. The yield to the acre varies from 20 to 200 bushels of shelled corn.

The following premium crops of corn were grown in Kentucky in 1850. There were nine competitors, and the surface in cultivation ten acres by each competitor.

J. Matson,	189	bushels, 1 quart	per acre.
P. Pean,	189	"	"
S. H. Chew,	137½	"	"
J. Hutchcraft,	115	"	"
A. Vanmeter,	108⅓	"	"
E. Hedges,	107	"	"
E. W. Hockaday,	100	"	"
Dr. B. W. Dudley,	100	"	"
H. Varnon,	98	"	"

or, 11,440 bushels 10 quarts shelled corn off 90 acres, perhaps the largest quantity ever raised from the same area. (*D. Lee.*) But it shows what corn can produce under good cultivation and favorable circumstances.

281. I. Inorganic ANALYSIS of white Flint corn, sown on a sandy loam and manured in part with coal ashes, *(Salisbury,)* New York:

	Kernels.	Leaves.	Cob
Silica, - - -	9.50	53.550	13.600
Alkaline Phosphates, -	35.500		
Earthy Phosphates, - -		19.250	23.920
Lime, - - -	0.160	6.092	0.300
Magnesia, - - -	2.410	1.250	0.900
Potash, - - -	23 920	12.762	35.802
Soda, - - -	22 590	8.512	5.914
Chlorine. - -	0.405	9.762	0.132
Sulphuric acid, - -	4 385	4.185	0.345
Organic matter, - -	0.367		2.314
Carbonic acid, - - -			6.134

II. Southern corn *(Shepherd,)* 100 parts gave 0.95 parts ash, composed:

Silica, - - - - -	38.45
Potash, with trace of Soda, - - - -	19.51
Phosphate of lime, - - - -	17.17
Phosphate of magnesia, - - - -	18.83
Phosphate of potash, - - - -	2.24
Carbonate of lime, - - - - -	2.50
Carbonate of magnesia, - - - -	2.16
Sulphate of lime and magnesia, - - -	0.79
Silica, (mechanically present,) - - -	1.70
Alumina, - - - - -	trace
Loss, - - - - - - -	1.65
	100.00

III. Corn, (United States.) *(Fromberg.)*

Potash, - - - - -	26,63
Soda, - - - - - -	7.54
Magnesia, - - - - -	15.44
Lime, - - - - - - -	1.59
Phosphoric acid, - - - -	39.65
Sulphuric acid, - - - - -	5.54
Silica, - - - - - -	2.09
Peroxide of iron, - - - - -	0.60
	99.08

It will be perceived from these analyses that Indian corn va-

ries very greatly in its inorganic constituents. But we are led to believe that it varies still more in Europe, if Liebig *(Agricul. Chem.,)* is correct in stating: "There are certain plants which contain either no potash or mere traces of it. Such is Indian Corn. *(Zea mays.)* For plants such as these the potash in the soil is of no use, and farmers are well aware that they can be cultivated without rotation on the same soil."

The water in dry corn varies from 10 to 15 per cent.; but as high as 37 per cent. when first ripened.

282. Organic analysis of various varieties of corn grown in New York. *(Salisbury.)* Golden Sioux corn, 12,—14-rowed, an improved variety of Buell's Dutton corn (A,) Ohio Dent corn (B,) small 8-rowed corn (C,) White Flint, grown on clay loam, and manured with coal ashes, horse dung, and unleached wood ashes (D,) large 8-rowed yellow corn (E.)

	A.	B.	C.	D.	E.
Starch, - -	36.06	41.85	30.290	40.34	49.22
Gluten, - - -	5.00	4.62	5.600	7.69	5.40
Oil, - - -	3.44	3.88	3.900	4.68	3.71
Albumen, - - -	4.42	2.64	6.000	3.40	3.32
Casein, - -	1.92	1.32	2.200	0.50	0.75
Dextrine, - - -	1.30	5.40	4.615	2.90	1.89
Fibre, - -	18.50	21.36	26.800	18.01	11.96
Sugar and extractive matter,	7.25	10.00	5.200	8.30	9.55
Water, - - -	15.02	10.00	13.400	14.00	14.00

When the dough of Indian corn is washed with water, a glutinous residue is left different from the gluten of wheat, and characterized by its solubility in alcohol, and therefore altered to vegetable gelatin.

The organic composition of corn in Europe differs from the above according to the following analyses. (*Knapp and Payen.*)

	Indian Meal from Hohenheim.	Indian Meal from Polenta Vienna.	PAYEN. Grain of Corn.
Gluten, Albumen,	14.66	13.65	12.3
Starch,	66.34	77.74	71.2
Sugar, gum,	18.18	7.16	0.4
Fatty matter,			9.0
Husk,			5.9
Ash,			1.2

The amount of inorganic matter taken from an acre of the soil by the small white Flint corn is: *(Gould.)*

Silicic acid,	210.14 lbs.
Phosphates of iron, lime, and magnesia,	94.58 "
Potash,	64.71 "
Soda,	63.00 "
Lime,	15.69 "
Magnesia,	9.69 "
Chlorine,	19.62 "
Sulphuric acid,	30.34 "
	881.85 lbs.

Of organic matter there is taken from one acre:

Sugar and extract,	2,892 lbs.
Starch, (in kernel only,)	5,139 "
Rosin, (in cob only,)	15 "
Fibre,	11,526 "
Albumen,	817 "
Casein,	396 "
Zein, (in kernel only,)	143 "
Dextrine and gum,	1027 "
Oil, (in kernel only,)	312 "
Chlorophyl and wax,	171¾ "
Glutinous matter,	420 "
	22,546 lbs.

Of this, 8,008 lbs. are taken off by the kernels, leaving 14,538 lbs. for the rest of the plant. Of the inorganic matter 99 lbs. are contained in the kernels, leaving 782 lbs. for the stalks, leaves, &c.

Amount of the several proximate organic bodies in a ton of each of the following parts when ripe. *(Salisbury.)*

	Leaves.	Sheaths	Stalks.	Cob.	Kernels.
	lbs.	lbs.	lbs.	lbs.	lbs.
Sugar and extract, -	336.000	180.000	186.660	94.000	266.40
Starch, - -				trace.	1186.00
Resin, - - -				12.500	
Fibre, - -	1086.000	1338.000	1402 660	883.760	17.80
Matter by potash, -	139.340	116.640	71.340	314.240	119 80
Albumen, - -	160.800	70.060	12.000	10.500	85.80
Casein, - - -	34.660	8.040	72.000	2.000	1.60
Zein, - - -					33.60
Dextrine and gum, -	116.00	57.600	105.340	16.000	65.20
Oil, - - -					72.00
Resin, chlorophyl and wax, -	82.660	12.040	84.000	51.240	
Glutinous matter, -		57.400			
Water, - -	55.340	167 400	71.400	626 400	169.900

Percentage of dry matter in the following several parts of Small White Flint Corn, when ripe. *(Salisbury.)*

Leaves, - -	40.108	Ear stalks, - -	11.128
Sheaths, - - -	29.342	Kernels, - - -	62.540
Stalk, - -	13.635	Cob, - - -	45.652
Tassel, - - -	58.722	Silks, - - -	18.825
Sheaths of husks, -	30.643		

The following table shows about the amount of the several proximate organic bodies thrown away in rejecting the cob, calculated from the analysis of the Small White Flint variety. 1000 lbs. contain not far from 200 lbs. of cob, and 800 lbs. of grain. These contain the following proportions, expressed in pounds and decimals of a pound. *(Salisbury.)*

	200 lbs. Cobs.	800 lbs. grain.	1000 lbs. ears.
Sugar and extract, -	13.582	115.320	128.902
Starch, - -	0.003	487.384	487.387
Fibre, - - -	127.687	7.712	135.399
Oil, - - -		39.824	39.824
Zein, - - -		31.856	21.856
Matter seperated by potash from fibre, -	45.404	51.856	97.360
Albumen, - -	1.518	37.136	38.654
Casein, - - -	0.288	00.688	0.976
Dextrine or gum, -	2.310	28.224	30.534
Resin, - - -	1.806		1.806
Glutinous matter, -	7.402		7.402

In the above table the inorganic matter is not seperately considered, it being distributed among the several organic bodies. By rejecting the cobs of 1000 lbs. of dry ears about 200 lbs. of organic matter is lost which consist of 13¼ lbs. of sugar and extract, 227½ lbs. of fibre, 45½ lbs. of water soluble in potash, 1½ lbs. of albumen, ¼ lb. of casein, 2.31 lbs. of gum or dextrine, 1.8 lbs. of resin, and 7.4 lbs. of glutinous matter. Hence the cob, although not rich in nutritive matter, can by no means be said to be destitute of these proximate principles which go to support respiration and sustain animal heat, and those which are capable of being transformed into nerve, muscle, &c., and the phosphates which contribute so largely to the formation of bone.

Inorganic composition of the ash of the ripe cob. (*Salisbury.*)

Carbonic acid,	9.455
Silicic acid,	10.320
Sulphuric acid,	1.336
Phosphoric acid,	13 105
Lime,	3 833
Magnesia,	6.745
Potash,	34.400
Soda,	11.495
Chloride of sodium,	1.980
Organic acids,	6.430
Phosphate of peroxide of iron,	.445
	99.544

Of all the twenty-seven varieties of corn examined by Dr. Salisbury, the Rhode Island Sweet is the richest in albumen, oil, and dextrine, and the most deficient in starch. As a general rule, those varieties with full corneous kernels are richer in the nitrogenized bodies and oil, and less rich in starch than the indented kinds; and of the corneous sorts with distended grains, the yellow seems to be richer than the white in oil, and those bodies which contain nitrogen, and less rich in starch.

According to Fresenius, the *oil* of corn consists of:

Carbon,	79.68
Hydrogen,	11.53
Oxygen,	8.79

283. Inorganic analysis of the leaves of corn at different stages. (*Salisbury.*)

	July 19.	Aug. 2.	Aug. 23.	Aug. 30.	Oct. 18.
Carbonic acid, -	5.40	2.850	0.65	3.50	4.050
Silica, - - -	13.50	19.850	34.90	36.27	58.650
Sulphuric acid, -	2.16	1.995	4.92	5.84	4.881
Phosphates, - -	21.60	16.250	17.00	13.50	5.850
Lime, - -	0.69	4.035	2.00	3.38	4.510
Magnesia, - -	0.37	2.980	1.59	2.30	0.865
Potash, - -	9.98	11.675	10.85	9.15	7.333
Soda, - - -	34.39	29.590	21.23	22.13	8.520
Chlorine, - -	4.55	6.020	3.06	1.63	2.664
Organic acids, - -	5.50	2.400	3.38	2.05	2.200
	98.14	97.750	99.58	99.75	99.523

Proximate organic analysis of the leaves at different stages of growth, calculated with the water. *(Salisbury.)*

	Aug. 2.	Aug. 23.	Oct. 18.
Sugar and extract soluble in alcohol, -	1.110	3.300	16.800
Do do insoluble in alcohol, -	1.890		
Fibre with a little chlorophyl, -	1.390	3.350	54.300
Fibre, - - - -	8.620	6.950	
Matter seperated from fibre by a weak solution of caustic potash, -	0.290	2.380	6.967
Albumen, - - - - -	trace.	0 020	8.040
Casein, - - - - -	0.730	0.100	1.733
Dextrine or gum, - - -	0.850	1.270	5.800
Oil and resin, - - -	0.150	0.139	4.133
Chlorophyl and wax, - - -			
Water, - - - - -	86.762	82.482	2.767

284. Dr. Jackson found 100 grains of the *Chit* yield 6.4 grains of ashes (§279. ii) which consisted of:

Phosphate of lime, - - - -	2.4
Phosphate of magnesia, - - - -	0.8
Phosphoric acid, a little potash, silica, and oxide of iron, -	3.2
	6.4

In composition, the Chit differs materially from the rest of the kernel in containing a very large per centage of oil and albumen, and a small per centage of starch. In the analyses of the Chit, the oil amounts to from 26 to 30 per cent., and the albumen from 17 to 20 per cent. of the dry matter, while the starch ianges from about 10 to 12½ per cent.

285. The feeding qualities of corn are universally known; and throughout the greater portion of the United States, it is used as bread for man, and depended on for fattening hogs and beef. There do not appear, however, to have been many accurate experiments made to ascertain how many pounds of corn are requisite to make a pound of meat. There are many difficulties in the way of arriving at accurate results in these respects. Different breeds, and even individuals of the same breed possess different fattening qualities; we have seen that the variety of the corn used must make much difference; cleanliness, and mode of feeding make more still; while corn ground and cooked is found to possess much more nutritive power, bushel for bushel, than when fed in its natural state. The following table, compiled from some experiments by Mr. H. L. Ellsworth, may be considered as an approximation towards the relative value of raw unground, and cooked ground corn,—though owing to peculiar circumstances the hogs fed on mush did not make as good progress as they ought to have done:

No.	Weight when put up	Fed daily.	Weight at end of 15 days.	Gain.	Fed in all in 15 days.	Value of corn when pork is 3 cents per lb.
1	131 lbs 4 oz	3½ lbs. meal	149 lbs 13oz	18 lbs 9 oz.	105lbs meal	55 cts pr bush
2	150 lbs 4 oz	cooked, each.	165 lbs 13oz	15 lbs 9 oz.		
3	157 lbs 4 oz	7 lbs raw	179 lbs 13oz	22 lbs 9 oz.	210lbs corn	38½ c pr bush
4	120 lbs 4 oz	corn, each.	146 lbs	25 lbs 12 oz		
			End of 20 days.		In 20 days.	
1	149 lbs 13oz	14 lbs raw	179 lbs	29 lbs 3 oz.	280 lbs c'rn	31 cts pr bush
2	165 lbs 13oz	corn, each.	189 lbs	23 lbs 3 oz.		
3	Sick.	2½ lbs meal				
4	146	cooked, each	166 lbs	20 lbs	70lbs meal	48 cts pr bush

Thence it is deduced that raw food is to cooked food as 68 to 103, making the gain by cooking 55 per cent. over uncooked food; or 3 bushels of meal cooked is equal to $4\frac{1}{2}$ bushels of dry hard corn. Or looking at this table in another light; the farmer selling his corn by turning it into pork, would receive 55 cents a bushel if it was fed cooked, while he would only receive $38\frac{1}{2}$ cents per bushel if fed raw. It is generally estimated that if

corn is cut up and fed to hogs in the field, 15 bushels will fatten each one; that is, add 100 lbs. weight of flesh. If hogs at gross weight are worth $3,00 per cwt., this makes corn worth 20 cents per bushel. If hogs are confined in pens, raw dry corn is worth 30 cents, and cooked meal 50 cents per bushel; so that the gain by grinding and cooking, over feeding in the field is 150 per cent. The manure, in the calculation of a skilfull farmer, should cover the incidental expenses of fire, feeding, &c. It is to be observed, however, from the above experiment, that hogs fed on mush did not increase in weight so *rapidly* as the others. Considering that many millions of bushels of corn are annually fed to animals in the United States, it is of great economical importance, worthy of the attention of the Federal and State Governments, that extensive and accurate experiments should be made as to the most economical mode of fattening stock. If we suppose—and we put the case in all respects lower than the truth is believed to be—200,000,000 of bushels of corn, bearing a market value of 25 cents per bushel, are annually fed to hogs, and by improved means of feeding a saving of 25 per cent could be made, it would leave 50,000,000 bushels, worth twelve millions five hundred thousand dollars to be applied to other purposes; and which now are annually thrown away, without being of any possible value, either direct, or indirect, to man.

Mr. Ellsworth, however, observes that "where land is cheap and easily tilled, and labor dear, as in the West, it may be best to make hogs their own harvesters. My present impression is, that [in Indiana] the most profitable way to feed corn, all things considered, is to cut the corn, as soon as it begins to turn hard; then hogs will eat corn, cob, and stalk; then too, the weather is mild, and swine will thrive much faster in September, October, and November, than in December, January, and February." This calculation is, of course, based on peculiar circumstances confined to certain localities.

286. Corn meal, owing to deficiency in gluten, &c., does not *rise* with yeast like wheat flour. The different varieties make different qualities of bread. The Southern and "Oregon" varieties are preferred for this purpose, as containing more starch. Yellow corn has more flavor, and absorbs more water than the white. In France it has been found that 150 lbs. of corn will make from 215 to 223 lbs. of good bread. Mr. Ellsworth found that 14 lbs. of good corn meal, thoroughly cooked, will make 90 lbs. of mush, so thick as not to run when taken out of the kettle; so that, in this form, the power of absorbing water is very great. The quality of bread likewise depends upon the mode in which the corn is ground. In the South, the mill stones are dressed so as to *cut* the meal into sharp particles, and not to *crush* it into powder as is done in wheat-flouring mills,—the corn being fed to the stones by handfuls at a time. Meal is often mixed with rye or wheat flour, and thus made into loaves.

Dr. Clos has lately given, in the *Journal d'Agriculture pratique*, the result of certain experiments made to ascertain the comparative economical value of Yellow and White corn, grown in the South of France. He found that Yellow corn meal when cooked absorbed water, and made mush as follows:

Weight of Meal employed.	Weight of Mush.	Difference, or weight of water absorbed.
Kilogramme.	Kilogramme.	Kilogramme.
3.794	11.932	8.138
3.488	11.136	7.648
3.549	12.054	8.505
Total, 10.831	35.122	24.291
White corn meal, cooked in the same manner gave:		
3.977	11.075	7.098
3.977	11.442	7.465
4.161	11.687	7.526
Total, 12.115	34.204	22.089

The Yellow corn gives a larger quantity of mush in proportion to the meal used, and each kilogramme of meal absorbs over two kilogrammes of water, while the White corn meal absorbs less than two kilogrammes,

or the mush of the Yellow is in proportion of 39.285 to 34.204 of the White from the same weights of meal. The Yellow meal, on sifting, gave less bran and more useful meal than the White by one-twentieth. It was further shown (*a,*) that the Yellow corn is drier and harder; (*b,*) resists moisture and is kept more easily; and (*c,*) weighs more per bushel than the White. The same experiments repeated in America could not fail to be useful. (*A kilogramme,* is 2 1-5 lbs. avoirdupois.) Mr. Gould has stated that 10 lbs. 12 oz. of Long Island corn grew on a given space, while 15 lbs. 2 oz. of large 12-rowed red corn grew on the same space of a precisely similar soil. The large White Flint yields 2.4 tons of grain to the acre on the same soil where the large Yellow Sioux yields 3.5 tons per acre.

287. The stalks, leaves, and husks, have a great nutritive value for fodder. When well saved, being cut before they are fully ripe, they are probably very nearly equal in this respect to common hay. They contain much sugar; and are believed to be more valuable than hay when fed to milk cows; producing a larger quantity of milk; but no accurate experiments seem to have been made. In 1848, the Commissioner of Patents procured from seventeen States, estimates of the supposed value of corn fodder, and it varies from $1 to $5 per ton; exclusive of manure made from it. If stalks are given to cattle in their natural state, a large portion, and that the heaviest, is wasted; but if cut and mixed with a little meal, nearly the whole will be eaten. The relative value, therefore, will of course depend on the mode of feeding. Again, it must be taken into consideration whether the husks are left on the stalks or not; the practice varying in different localities. The size of stalks also makes a difference, the small northern corn containing more consumable fodder than the large southern; and some varieties are believed to be much richer in sugar, and probably albumen than others.

288. The cob, also, when divested of grain, contains a notable amount of nutriment. Most animals will eat it when soft, but refuse it when hard. Mr. Ellsworth had cobs crushed and ground, and kept his store hogs and other stock through the

winter upon the meal. The cob is often crushed and ground with the corn when intended for fattening animals, and produces a good effect mechanically as well as nutritiously. Oxen, however, are supposed to suffer from the fibres collecting in and obstructing the intestines.

289. Green corn stalks afford a saccharine juice which can be crystallized into sugar. Many experiments were made in this direction a few years ago, but the cost was found too great to compete with cane sugar. The time, however, may come when this manufacture will prove profitable, as that of Beet sugar is at present in France.

290. Corn is frequently sown broadcast to be cut green for *soiling*, when the grain becomes of secondary importance.

291. Corn may be made to grow, with manure and skilful cultivation, upon almost any kind of soil, but the land peculiarly adapted to it is that which contains a large per centage of vegetable matter, is fine, friable, warm, deep, and sufficiently supplied with moisture by evaporation. Prairies, and diluvial deposites along rivers, may be called the natural habitat of corn. It will grow where wheat prospers, but wheat will frequently not mature profitably in the best corn lands.

The following is an analysis of a rich corn-bearing soil in Ohio, occasionally overflowed by the Scioto River. It has been cultivated fifty-one years; and has borne forty-five crops of corn, and two or three of wheat, and been a few years in grass or clover. With the most ordinary culture it yields 80 bushels of corn to the acre. (*D. A. Wells.*)

I. Constituents soluble in pure water:

Total percentage 0.190	Extract of earth, alkaline, chlorids, &c.,	0.032
	Organic matter, crenic acid,	0.010
	Iron, lime and silica,	0.012

II. Constituents soluble in dilute acid:

Total acid extract 5.011	Iron, alumina, and manganese,	2.760
	Organic matter, combined with the above,	0.860
	Silica,	0.560
	Lime,	0.390
	Magnesia,	0.280
	Phosphoric acid,	traces.
	Potash and soda,	0.161

Organic matter rendered soluble by ammonia, - -	3.140
" " " " " - - -	1.030
" " remaining with insoluble residue, - -	1.720
Insoluble silicates, - - - - - -	83.010

100 parts of the insoluble residue gave 59 parts silicious, and 41 parts clayey matter.

Water, hygroscopic and combined, - - -	3.500
Resinous and waxy matter, - - - - -	.036

The most striking fact in connection with these soils is the exceeding fineness of their particles.

A deep rich mellow soil, in which the roots can freely extend a great distance in depth and laterally; and where, owing to the fineness of the soil, they will not be injured by drought, nor hidden from the heat of the sun, and from atmospheric influence, is what the corn grower should provide for this crop. A compact clay which excludes alike air, water, and rapid growth of roots, forbidding all chemical changes, is not the soil for corn. As it grows rapidly it requires a constant supply of food, and this can only be attained where there is water enough to act as a solvent to the solids. As will have been observed in the inorganic analyses, the per centage of ash in corn is comparatively small, organic matter and water forming the great mass of the tissue.

292. A great variety of manures are applied to this crop according to the requirements of the soil. Organic manures,—barn-yard dung and such like—are those which will most generally prove serviceable; and next to these, decayed vegetable matter. In consequence, corn is found to succeed well on grass or clover sod. Of the inorganic manures, dissolved bones, unleached wood ashes, salt, and plaster, promise to do good, *if* the soil is deficient in these elements.

293. When corn is planted on sod, *(a,)* spread manure on the grass; *(b,)* plow deep, laying the furrow flat; *(c,)* roll, and *(d,)* harrow with a long sharp toothed harrow, or a cultivator, till the surface is rendered friable two or three inches or more,

deep; both of these processes being lengthwise of the furrow; *(e,)* spread compost, or well decayed dung, and harrow it in again. If corn is to be planted on stubble, one plowing, and a thorough harrowing, with the same application of manure, is all that is requisite.

294. Corn is planted, *(a,)* by hand with a hoe, or *(b,)* by a drill, either *(c,)* in hills, or *(d,)* rows; and these latter either *(e,)* equal or *(f,)* alternate. If by hand, the lines are laid out by *(g,)* a light plow drawing a shallow furrow both ways across the field, so as to divide it into squares, at the proper distance, or *(h,)* by a *corn marker*, a coarse implement made somewhat similar to the form of a hay rake, with the teeth or pins at the distance apart proper for the corn; the whole being drawn by a horse; *(i,)* the drill will plant either in hills or rows. The usual distance apart for hills is three to five feet each way, according to the size of the corn; for rows three to four feet, and the plants nine to twelve inches apart in the row.

The amount per acre of the crop depends much on the mode of planting. In a favorable soil it rarely happens that each original stalk does not produce one ear; allowing these ears to produce in shelled corn one gill each, the amount produced per acre by different methods of planting will be as follows,—four stalks being allowed to each hill when planted in that form:

One acre	in hills	4 feet apart,	gives	2,722	hills or	10,885	stalks.
"	"	" 3 "	" "	4,840	"	19,360	"
"	"	" 3 ft. by 2½ ft.	"	5,808	"	82,232	"
"	"	in drills 3 ft. and 6 inches for plants,			-	29,040	"
"	"	in double drills thus:					

    *   *   *   *   *   *
 *   *   *   *   *   *   *

6 inches apart, the plants 9 inches in the rows, and 3 feet 9 inches from the centre of the drills would have 30,970 stalks. An acre planted 3 rows in a drill thus:

 *   *   *   *   *   *   *
    *   *   *   *   *   *
 *   *   *   *   *   *   *

rows 6 inches apart, and the plants 9 inches in the rows, with a distance of 3 feet from the centre of the drills would have 43,560 stalks, or 170 bushels; while the hills, 4 feet by 4 feet, could only give 42 bushels. A crop of 170 bushels to the acre was actually raised, some years since, in Madison county, New York, on the three row system.

295. The proper depth at which to plant the corn is about 1 inch to 1½ inches.

The following experiment was made by Burger, in Germany:

Indian corn which was planted at the depth of

No. 1,	1 inch,	came up in	8½ days.
No. 2,	1½ inches,	came up in	9½ days.
No. 3,	2 inches,	came up in	10 days.
No. 4,	2½ inches,	came up in	11½ days.
No. 5,	3 inches,	came up in	12 days.
No. 6,	3½ inches,	came up in	13 days.
No. 7,	4 inches,	came up in	13½ days.
No. 8,	4½ inches,	came up in	— days.
No. 9,	5 inches,	came up in	— days.
No. 10,	5½ inches,	came up in	17½ days.
No. 11,	6 inches,	came up in	— days.

Nos. 8, 9, and 11, were dug up after 22 days, when it was found that No. 8, had an inch more to grow to reach the surface. Nos. 8, and 11, had just sprouted but were short, and 3 inches below the surface. No. 10, came up in 17½ days, but withered after 6 days growth. The more shallow the seed was covered by the earth, the more rapidly the sprout made its appearance, *and the stronger, afterwards, was the stalk.*

Corn will not germinate unless the temperature of the soil attains to 55° Fahr., and at a temperature higher than 110° it equally refuses to vegetate.

"Much of the damage which is supposed to arise from planting in the 'wrong time of the moon,' is really due to planting when the soil is at the wrong temperature, and if the time ever arrives when the average crop of the country is equal to what our premium crops now are, it

must be when every farmer owns a thermometer and knows how to use it." (*J.S. Gould.*)

An experiment was made in Connecticut in 1844 to plant corn three inches deep. It came up and grew well until it was three or four inches high, and then stopped for a fortnight, while the same corn planted at a less depth grew rapidly. On examination it was found that a joint had been formed about an inch and half above the kernel, and that the roots had sprouted out from the joint *leaving all below to perish.* While the process of changing roots was going on the plant ceased to grow above ground, but in about a fortnight recovered its vigor; and it was about that length of time later in maturing the grain, than the seeds which were planted shallower.

296. The following table will show the quantity of seed, required, on an average, to plant an acre in hills.

Distances of the hills apart.	Quantity required 4 grains to a hill. QUARTS.	Quantity required 5 grains to a hill. QUARTS.
3 feet by 2 feet, -	14.52	18.15
3 " by 3 " - -	9.68	12.10
3½ " by 3 " -	8.30	10.37
3½ " by 3½ " - -	7.11	8.89
4 " by 3 " -	7.26	9.08
4 " by 3½ " - -	6.22	7.78
4 " by 4 " -	5.44	6.80

297. The culture of the corn after it is above ground varies much. While some put a small quantity of ashes and plaster in the hill at planting, others wait until the corn is a few inches high. It will only be necessary shortly to state the various processes which are then pursued; *(a,)* hoe, plow both ways, throwing the earth into hills round the corn, hoe and plow again; *(b,)* hoe and plow, as above, but keep the earth level, and not raised, around the roots; *(c,)* hoe, but avoid plowing or hilling, cutting up the weeds, and rendering the surface friable with the cultivator. It is quite necessary that weeds should not be allowed to grow, and that the earth should be frequently stirred; but whether deep plowing, or the use of the hoe and cultivator alone are best is a disputed point; and probably depends on the nature and richness of the soil.

These directions only apply to the Northern and Atlantic States. In the rich Western Prairies and river bottoms, corn culture is a much more simple process.

298. It is a custom with some to plant corn five to eight feet apart in rows, and in the fall to plow between them, and sow wheat. As a system of rotation, this mode appears to possess peculiar advantages. For particulars, see *Mr. Bartlett's* letter in the *Farmer's Companion and Horticultural Gazette*, November, 1853. Pumpkins are generally planted in each alternate hill or row. In Virginia, peas are sown between the rows after the last hoeing, to be afterwards eaten off by hogs. In a similar manner clover is sown in New Jersey.

299. It is also customary to steep corn before planting to *(a,)* prevent birds and insects from injuring it; *(b,)* to act as a manure. For the first purpose soak the corn a few hours in warm water, and then mix it with tar thrown into water sufficiently hot to melt it. Each grain will be thinly coated with tar. Dry with plaster or ashes. For the second, use a weak solution of saltpetre, or salammoniac, *(Muriate of ammonia,)* 1 lb. to 4½ bushels, or 1 oz. to a quart of grain—mixed in warm water, and poured over, to remain upon the corn for 18 hours before planting. The corn sprouts with a rich green color, and grows rapidly, but whether it finally increases the crop is still disputed.

300. To grow corn broadcast for fodder, rich clean land is required. It is prepared with one plowing, is slightly harrowed, and the corn sown at the rate of 3 to 4 bushels to the acre. It is then harrowed in and rolled. It is sometimes planted in drills, and worked with the cultivator.

301. The best time for harvesting, or cutting the corn is when the grain is *glazed*, but not yet perfectly hard, and the stalks still partially green.

302. Previous to this process, and at the time when the ears

but not the grains were fully formed, it used to be the custom to *top the corn, i. e.*, cut off the stalks and leaves above the highest ears; but this is now generally abandoned. Truer views of the physiology of vegetation have taught that the leaves are necessary for the elaboration of the sap which forms the grain; and careful experiments proved that when the plant was thus deprived of part of its foliage, the grain was lighter and the ear not so well filled, although it might ripen a little earlier.

303. In the Southern States, it is customary to pluck the leaves of corn, dry them for fodder, and stack them, leaving the stalks standing in the field, to be afterwards eaten by stock, or plowed in. As this is generally done before the grain is formed, the same injurious results follow as in topping.

The following experiment was tried in South Carolina in 1846. Twelve rows of corn, as nearly equal in appearance as could be found, were selected. Nos. 1, 4, 7, 10, (A,) were left with the leaves on, until they were generally dry as high as the ear, and, on some stalks to the top. They were then cut up at the roots; shocked on the field until the other grain was gathered in; they were then hauled in and husked from the stalk. Nos. 2, 5, 8, 11, (B,) were left with the blades on until quite ripe. Nos. 3, 6, 9, 12, (C,) were stripped of their blades before ripening, but as late as usual. The results were as follows:

A,	when shelled,	measured	4	pecks,	1	gallon,	2	quarts,	1	pint, weighed	70½ lbs.
B,	"	"	4	"	1	"	2	"	1½	" "	71½ lbs
C,	"	"	4	"	0	"	0	"	½	" "	55 lbs

The fodder, taken from the last, weighed 18 lbs., which added to the weight of the corn is 73 lbs.—1 1-2 lbs. more than the corn alone from which no leaves were taken. It thus appears that this process deprives the corn of nearly the weight of the fodder when cured, without reckoning the time also consumed in taking the leaves off.

304. Corn is harvested by cutting close to the ground, with a heavy knife manufactured for the purpose, or part of a scythe blade, fixed to a handled of some sort. Several hills are laid together, and bound with a corn stalk; with straw rope; or other cheap band. These bundles, to the number of 4 to 8, are then tied around the stalks of a hill left standing for the purpose.

There are various modifications of this process, but all on the same principle. The corn thus stands, until the leaves, stalks, and ears are dry; in the north, till after the first strong frost, the effect of which is to expel the remaining water.

Then the bundles are opened, and the ears of each stalk separated from the husk, thrown into baskets, and removed by wagon to the corn crib. The workman holds in his hand a short, sharp, piece of wood, generally attached by a string to the wrist, to facilitate the opening of the husk. The husks should remain attached to the stalk; and not be torn off as is too often done. The stalks are then again tied up, and left in the field till it is convenient to haul them to the barn, or stack them. When stacked out of doors great care must be taken that the rain does not get in, otherwise rot will rapidly ensue.

305. When sown broadcast, the stalks are usually cut while green, and fed to stock in stables. If retained till winter they may be cut, bound, and stacked as above. A little salt scattered among the stalks in stacking will be found useful to prevent moulding, and cause the animals to eat them more perfectly.

In 1845 over 31 tons of green corn stalks were raised to the acre in Massachusetts. The product of two acres 32 rods, fed 20 cows, 1 heifer, 2 bulls, and 5 spring calves for 7 weeks and 5 days; the *dried* produce off the same acre being estimated as equal to 15 tons of the best "English" hay. This production, however, is much greater than what is generally obtained. Ten bushels of "white flat Maryland corn" were sown on the 2 32-160 acres. Corn is sometimes sown broadcast for the purpose of plowing it in as a manure for wheat.

306. Corn is seperated from the cob by *(a,)* thrashing with a flail; *(b,)* treading with horses; *(c,)* a machine called a *corn-sheller*, of which there are several sorts, some moved by hand, others by horse power. If required to be very clean the corn is then passed through a fanning mill.

The following is a rule for finding the quantity of corn, shelled or in ear, in a house of any dimensions. Having previously levelled the corn in the house, so that it will be of equal depth throughout, ascertain the

length, breadth, and depth of the bulk; multiply these dimensions together; and their product by 4; then cut off one figure from the right hand of this last product. This gives the bushels, and decimal of a bushel of *shelled* corn. If corn *in the ear*, substitute 8 for 4, and cut off one figure as before.

EXAMPLE :—

12	feet long.
11	feet broad.
132	
6	feet deep.
792	
4	multiple for shelled corn.
316.8	bushels in house.

When 8 is used as a multiple to find the quantity of corn in the ear, it is on the ground of 2 bushels of such making 1 of shelled grain.

There are other rules given for the same purpose which do not agree with this, and it appears that the accuracy of this mode of measuring requires further testing.

307. It is very important that the best ears should be saved for seed; as corn rapidly degenerates or improves according to the seed planted. Careful farmers select the best ears while husking; leave part of the husk attached to them; plait them together; and hang them up in a dry room. Corn not perfectly ripened or dried, *heats* when thrown together in large quantities, and the germinative power is lost. Two years ago, owing to early frosts, the corn in Michigan was imperfectly dried; and, in the spring, corn taken from the crib very generally failed to grow; while, preserved in the house, as above recommended, it is said no failures occurred. The loss of labor and time, and of the crop in consequence, was estimated at many thousand dollars in this one State alone. It is found advisable to change the seed every few years, procuring the new from a location further north, and from a different soil.

308. In the southern, and middle western States, it is customary to turn hogs and cattle into the field of standing corn, but this is a very

wasteful proceeding, unless labor is very costly. In south Ohio, the corn is cut and tied in bundles, and daily hauled to a small field, where stalks, grain, leaves, &c., are thrown on the ground for the fattening cattle to eat. The next day, these are removed to a second field, and their place is taken by a drove of hogs, which pick up what the cattle have wasted or refused. Thus, the two are fed alternately in different fields; and the swine fattened at comparatively little cost.

309. If the cobs are not ground for feed, they should be mixed with animal manures in a state of fermentation, when they will gradually decay. They contain many valuable elements of manure. They are occasionally used for smoking hams, and some other minor domestic purposes.

310. There are no weeds peculiar to this crop. Indeed a skilful farmer will not allow a solitary weed to grow among his corn; and thence it is an excellent crop for cleaning foul land.

311. Corn is subject to the growth of a very peculiar and destructive fungus or *Brand.*

Maize Brand (*Uredo maydis.* De Candolle,) attacks all the parenchymatous organs of the corn plant, and more or less completely destroys them. The stalk, however, the female, and the male blossoms, are the parts which it most especially affects. Its development is a peculiar one, as it forces out great masses of cellular tissue, formed from the tissue of the mother plant, and similar in formation to the latter. Some parts of the organs affected by the brand swell and become white. This species always impairs some blossoms, as soon as it is seated in the ear, while the other blossoms standing near bear good ripe kernels. The brand bladders can be very easily removed from the living plants by cutting them out, only this must be done as soon as possible, in order that in cutting them out the bladders may not scatter their powder, and thus a future crop of brand not be prevented. For seed only, kernels should be selected from plants which have remained wholly free from the brand. This fungus is, by the structure of its spores, different from all others, and only related to the wheat brand. Corn in rich, *damp* loam appears more subject to this disease than in any other situation, and draining would probably prove an effectual cure. (*See Trans. of N. Y. Agricul. Socy., vol.* viii., p. 842.)

In the *Patent Office Report* for 1847, a description of a disease which

appeared in Maryland is given, and which we suspect to be another species of brand.

"The cap of the injured ear is discolored, and when opened a few grains near the apex of the ear, and one side of it, mark the commencement of the disease in their sickly and shrivelled appearance; this increases in space and intensity until the whole ear exhibits a deadly and gangreneous mass of black, rotten grains, while the whole plant on which it grows is erect, and of the most healthy and vigorous appearance." It did much injury to the crop.

312. The insects most injurious to the corn are:

(*A.*) *Cut-worms.* These are thick, greasy-looking caterpillars, from one to two inches in length, of a dark ashen grey color, with a brown head, a pale stripe along the back, and several minute black dots on each ring. They are the grub of a species of moth, belonging to a group called by Dr. Harris *Agrotidians;* and there are many species in the United States, each species *probably* confining itself to a particular family of plants, as one to the cabbage, another to grasses and grains, The moths fly by night, appearing in July and August. They lay their eggs either in the ground, or on the roots of plants in the autumn, and these are hatched in the spring, the Cut-worm being produced. These feed on plants, concealing themselves in holes in the ground during day, and appearing only at night. During the summer they become chrysalids; remain in that state about four weeks; and the moth again appears in the fall. The corn Cut-worm, is probably the *Agrostis messoria* of Harris. They feed only on the sprouts and young stalks and do not eat the seeds of plants.

(*B.*) *Wire-worm,* or *Iulus,* a hard, worm-like form, with the skin seperated into compartments or rings. It is not a true *Insect* as it undergoes no transformation; and belongs to the class *Myriapodia,* a name derived from the great number of feet with which most of the animals included in it are furnished. There are several species.

(*C.*) *Wire-worm.* In some localities, especially in new lands, and on plowing up old grass fields, another insect known by this name proves very injurious to young corn. They are long, slender, worm-like grubs nearly cylindrical, with a hard and smoth skin, of a buff or brownish yellow color, the head and tail only being a little darker; each of the first three rings are provided with a pair of short legs; underneath the last ring is a short retractile wart, or prop leg. These are the grub of a species of Beetle, the *Elaters* or Spring beetles, well known in this shape by the faculty they possess of throwing themselves up-

wards with a jerk, when laid on their backs. There are many species, some of which appear to be confined to rotten wood. It is believed that they remain in their feeding or larva state not less than five years, before changing into beetles. The grubs injure corn both by eating the grain when first sown, and also by cutting off the young plant just *below* the ground, as the Cut-worm eats *above* the surface.

(*D.*) *Spindle-worm.* This is the caterpillar of a moth (*Gortyna Zeæ,*) and is well known as destroying the *spindle* of corn. Its ravages, however, generally begin while the cornstalk is young, and before the spindle rises much above the tuft of leaves in which it is embosomed. The mischief is discovered by the withering of the leaves, and when these are taken hold of, they may often be drawn out with the included spindle. On examining the corn, a small hole may be seen in the side of the leafy stalk, near the ground, penetrating into the soft centre of the stalk, which when cut open will be found to be perforated, both upwards and downwards, by a slender worm-like caterpillar, whose excrementious castings surround the orifice of the hole. The grub grows to over an inch in length, and to the thickness of a goose quill. The chrysalis is lodged in the burrow formed by it; it is of a shining mahogany brown.

(*E.*) The grub of the *May-beetles,* (*Dor-bug, Cock-chafer, Anomala,*) injures corn by eating the roots. It is a white, thick, smooth skinned semipellucid-worm, with a brownish head, and when fully grown nearly half an inch in diameter. It is frequently thrown out of the ground in digging or plowing. When in a state of rest, it usually curls itself up in the shape of a crescent. It is supposed that it occupies from three to five years in the grub state, before changing.

(*F.*) *The Granary Weevil.* (*Fly Weevil—Grain moth—Angoumois moth,*) *Butalis cerealella,*) which is so destructive to stored wheat, is also injurious to corn in some localities, when it is kept unprotected more than six or eight months. (See §202.)

(*G.*) *The true Grain Weevil.* (*Curculio granarius,*) also attacks stored corn. (See § .)

(*H.*) The Grain moth (*Tinea granella,*) also feeds on corn under similar circumstances.

(*I.*) *Corn Weevil* (*Silvanus Surinamensis,*) is very commonly found among stored corn, as well as in other grains, and in sugar. It also infests mills. It is said that Sassafras Root, mixed with the grain, drives them away. (*For a very full description and a plate of this, and Calandra granaria, see N. Y. Trans. of Agricul. Society,* vol. viii., p. 656.)

313. A great variety of preventives have been tried, but only a few appear to be worthy of use. Salt, perhaps, is the most generally successful against such grubs as live in the ground: Two to four bushels per acre of fine salt being sown broadcast, and slightly harrowed in, a few days before planting. If the corn is to be planted on sod, fall plowing—late in the season—will affect some good; also steeping the grain in saline and ammonical liquors; and tarring. It has been recommended, and practised with success, to hang the seed corn in the smoke house, and smoke it with the hams: the pyroligneous acid appears to be offensive to insects and birds, while it does no injury to the grain. For insects injuring the ripe corn when stored, abundance of air, and thorough ventilation are the best preventives. A barrel, impregnated with tar, it is said will drive away the True Grain Weevil, (*C. granarius,*) (*g,*) if it is placed in the granary. It is thus employed in France. The farmer will find much profit in cherishing birds; even the red-winged Black Bird, (*Agelaius phœniceœus,*) and Crow Black Birds, (*Quiscalus versicolor* and *ferrugineus,*)—on his farm; for though they destroy some grain, it is but a choice of two evils; it being always found that where birds are driven away the loss by insects becomes extreme. A single pair of Crow Black birds will, in one season, destroy thousands of injurious grubs.

The whole subject of insects injurious to vegetation in America, still requires much study and persevering observation; and notwithstanding Dr. Harris' labors, there is yet much of practical importance to learn regarding it. We believe that the day will come when means will be discovered of preventing these ravages; but before this can take place, not only must the habits of the insects themselves, but also the peculiarities of the plants and soil be much better understood than at present. Many facts would lead us to believe, that an impoverishment of the soil is necessary before insects can become seriously injurious, as it is certainly connected with diseases of vegetation.

314. Many of the European physiologists, have for a length of time

been endeavoring to decide the question whether grains will germinate before they are fully ripe? The last writer on the subject, M. Duchartre, Professor of Botany in the Agronomic Institution of Versailles, has made many very complete experiments, with satisfactory results. We are only able to give here a summary of the truths he arrived at.

1. The grains of the cereals are able to germinate, if harvested at least twenty to twenty-five days before maturity, or complete ripeness, although the germ is yet very imperfect.

2. Such seeds require a longer time to sprout than those quite ripe, if sown immediately without drying.

3. The same proportionate number of seeds will grow in both cases, with the exception, perhaps, of barley.

4. Seeds imperfectly ripened germinate much more surely if they are well dried before sowing. In this case they sprout as soon as perfectly ripe seeds. It would appear that seeds harvested in an unripe state are able to mature themselves if kept for some time,—the embryo being nourished and developed at the expense of the moisture and albumen.

5. In practice, there need be no fear as regards sowing seeds of the cereals cut a long time before maturity, but the threshing should be deferred as long as possible.

6. Where the crop is large and laborers scarce, the harvest may be commenced much earlier than is usual, without any fear of injuring the grain.

7. The plants grown from seeds gathered twenty-five days before ripening, and allowed to dry for seven weeks, so far from being weak and inferior, were remarkable for their vigor, and on the whole no difference in this respect could be perceived in favor of well ripened grain. It would be well to make a series of similar experiments in America, as practically, it is a very important subject.

CHAPTER XI.

RICE.—BUCKWHEAT.—MILLET.—CANARY GRASS.

315. Rice has been known and cultivated from the earliest periods, and furnishes food to a large portion of the human family. Its native country is unknown.

316. There are two varieties, (*a*,) Common Rice; (*Oryza sativa*) and (*b*,) Cochin China, Dry, Upland, or Mountain Rice; with several subvarieties, as *Long Grain and Small Grain*, &c.

317. The first (*a*,) is cultivated in marshes; and, for a great part of its growth, is partially under water. It requires a warm climate. On the Eastern continent it matures as high as the 45th parallel of north lat. and as far south as the 38th. On the Atlantic side of the Western continent, as far north and south as 38° of lat. On the western coast as far north as 40° or more. It is cultivated in India, China, the Indian Archipelago, Eastern Africa, South of Europe, southern portion of the United States, and in parts of South America. It was introduced into Virginia in 1647, and into Louisiana in 1718. According to Boussingault it requires a minimum temperature of 75° F.

318. The second variety (*b*,) grows on mountains and dry soils; several degrees further north and south than the first. It is found high on the range of the Himalayan Mountains, and is cultivated in the northern provinces of China, in Hungary, Westphalia, Virginia, Maryland, Illinois, Missouri, &c. It was introduced into Charleston, S. C., from Canton, in 1772.

319. The States in which Rice is chiefly cultivated are

	1840.	1850.
South Carolina, -	60,590,861 lbs.	159,930,613 lbs.
Georgia, - -	12,384,732 "	38,950,691 "
Louisiana, -	3,604,534 "	4,425,349 "
North Carolina,	2,820,388 "	5,465,868 "
Mississippi, - -	777,195 "	2,719,856 "

Besides Virginia, Florida, Alabama, Texas, Arkansas, Tennessee, Kentucky, Missouri (700 lbs.) and Iowa (500 lbs.) The total crop of the United States was, 1840, 80,841,422 lbs; 1850, 215,312,710 lbs. The rice grown in South Carolina is considered the finest in the world, having much improved in quality in that State.

320. The *Wild Rice*, of the North Western Lakes, which is gathered and eaten by the Indians, belongs to a different botanical family, and is known as *Zizania aquatica*. It is not cultivated. The *Patent Office Report*, 1846, p. 289, mentions a grain by the name of *Hungry Rice*, cultivated at Sierra Leone, Africa, as worthy of introduction into this country; but it is probably a species of *Millet*, and not a true Rice.

321. Unhusked rice consists of: (*Johnston.*)

Husk, - - - - - -	20.91
Grain, - - - - - - -	79.09

Carolina Rice, (A,) and Rice Flour (B,) gave:

	A.	B.
Water, - - - - -	13.0	14.6
Ash, - - - - -	0.33	0.35

322. Considering a rice plant in its dry mature state to weigh 100 grains, the mineral matter in the different parts of the plant are as follows: (*Shepard.*)

In the stubble and root, - - - -	36.08
Straw and leaves, - - - -	36.08
Husk, - - - - - -	14.20
Cotyledon and Epidermis, - - -	11.70
Clean rice, - - - - - -	1.94
	100.00

323. Dry rice contains: (*Payen.*)

Starch, - - - - - - -	86.9
Gluten, &c., - - - - - -	7.5

Fatty matter,	0.8
Sugar and Gum,	0.5
Epidermis,	3.4
Saline matter, (*ash*)	0.9

Rice contains less fatty matter than any other grain, and the greater portion of the fat is contained in the outer coats. Johnston found in the siftings or cleanings of rice, from 5 to $5\frac{1}{2}$ per cent. of fatty matter.

324. Inorganic analyses of Rice grain (A,) and husk (B.) (*Johnston.*)

	A	B
Potash,	18.48	1.60
Soda,	10.67	1.58
Magnesia,	11.69	1.96
Lime,	1.27	1.01
Phosphoric acid,	53.36	1.86
Sulphuric acid,	——	0.92
Silica,	3.35	89.71
Peroxide of iron,	0.45	0.54

Varieties of rice from India give a much larger per centage of ash than those grown in the United States. This grain is probably less nutritious than any other ordinarily used by man; as it contains a comparatively small proportion of glutinous or nitrogenous matter.

325. The soil adapted for the common rice is of a marshy and wet character, containing much organic matter, which can be overflowed or drained when requisite; but it will grow (though less profitably) on light, moist uplands without irrigation, when cultivated with the hoe or plow. On wet lands, the embankments and ditches being prepared, the soil is well plowed, the seed sown at the rate of $1\frac{3}{4}$ io $2\frac{1}{4}$ bushels per acre, and harrowed in with a light harrow, thickly set with teeth. In South Carolina, from April to May, is the usual season. Immediately after, the water is let on, so as barely to overflow the ground. As soon as the grain begins to swell, the water is withdrawn. When the plant is three inches high, the water is

again let on, leaving the top leaves a little above it. A fortnight before harvest, the water is finally drawn off.

326. Rough rice, while the husk is still attached, is called *Paddy*; and large quantities are exported in this condition. A peculiar mill is required for cleaning the husk from the grain, and in this process large amounts of "Rice flour" are formed. The "flour," the chaff, and the straw are used as manure for this crop, and are deemed among the very best. The chaff is spread even over the surface, about three inches deep, and plowed in. The straw can be safely used when the field is fallowed. It is then put on the land thick, and bedded in. Prof. Shepard says "The planter who sells his crop in the condition of *Rough Rice*, robs his land of 27.84 per cent of the mineral ingredients of this species of produce, while on the other hand, he who sells it as clean rice, abstracts from them but 2 per cent. of these ingredients."

327. The Upland Rice is sown in April and is ripe in September. The usual method is to sow it in drills about 18 inches apart; but if the land is well prepared and clean, it may be sown broadcast.

328. The yield of an average crop of common rice in South Carolina is about 40 bushels per acre, while a good crop will give as high as 55 bushels. We find the product of 16 acres thus described when prepared for market:

Rough rice, 376 bushels, give of

Clean rice, - - - - -	10,754 lbs.
Small rice, - - - - -	16¼ bushels.
Flour, - - - - -	31 "

The Upland Rice yields from 25 to 30 bushels an acre.

329. Rice is measured by the Barrel of 600 lbs, and by the Tierce.

330. This grain is eaten boiled in its clean state; it is ground into flour; and starch is made from it. Manufactured on a large scale, Patna rice yields 80 per cent of *marketable* starch;

8.2 per cent. of fibrous starch granules; and 11.8 per cent. of gluten, bran, and a small quantity of light starch. In India, a fermented intoxicating liquor called *arrack* is prepared from it. When damaged, it is occasionally used for feeding hogs and fowls, and though deficient in oil, the large amount of starch which it contains enables it to fatten. The refuse from rice-mills is probably more fattening than the clean grain.

331. Microscopic examination of the soil of rice fields shows it to be filled with minute animal forms and shells capable of supplying a large amount of phosphoric acid, the chief inorganic ingredient of this grain.

332. BUCKWHEAT (derived from the German *Buchweitzen* "Beech-wheat," from the resemblance of the seeds to the Beech mast) is not properly a *grain*, but belongs to the family of *knotweeds*, of which there are twenty species in the Northern United States. It is probably a native of China. There are three cultivated species; (*a*,) Common Buckwheat, *Polygonum Fagopyrum;* (*b*,) Tartarian Buckwheat, *P. tataricum*, and (*c*,) Notch-seeded Buckwheat, *P. emarginatum*. There do not appear to be any varieties.

In the *Trans. N. Y. State Agricultural Society*, 1848, p. 572, mention is made of a *Blue Buckwheat*, grown in Sullivan county. Its peculiarities are, 1. It is less injured by the sun. 2. Can be sown earlier. 3. Weighs heavier; and 4. Makes from 3 to 5 lbs. per bushel more flour of a better quality, than common buckwheat. The flour sold for 25 cents per 100 lbs. more in the New York Market. In one instance it yielded 41 bushels per acre. Whether this is a variety, or one of the above mentioned, we are unable to decide.

The first is chiefly cultivated in America, the second in Italy, the last in China. In Europe it is grown for food from Russia to Italy, Great Britain excepted; and being a very short time in the ground, can be adapted to great differences of climate. In the United States it can be grown in every section, but is chiefly cultivated north of North Carolina and Tennessee. The total crop in 1840, was 7,291,743 bushels, and in 1850, 8,956,916; New York (3,183,955 bushels) and Pennsylvania

(2,193,692 bushels) being the largest producers. Michigan is the fifth largest, giving 472,917 bushels, being only inferior to Ohio and New Jersey. It has probably been grown in America about 150 years.

333. Organic analyses of Buckwheat flour from Vienna (A,) and Tartarian Buckwheat from Hohenheim (B.) (*Horsford and Krocker.*)

	A	B
Gluten and Albumen, - - -	6.88	9.94
Starch, - - - -	65.05	44.12
Woody fibre, Gum, Sugar, - - -	26 47	46.26
Ash, - - - -	1.69	2.30
Moisture in fresh substance, - - -	15.12	14.19

334. Inorganic analyses of Buckwheat from Cleves (*Bichon*) (A,) and New York. (*Salisbury.*) (B,)

	A		B
Chlorine, - - -	——		0.20
Potash, - - -	8.74		23.33
Soda, - - -	20.10		2.04
Lime, - - -	6.66		0.14
Magnesia, - - -	10.38		2.66
Oxide of iron, - -	1.05		
Phosphoric acid, - -	50.07	Earthy phosphates.	57.60
Silica, - - -	0.69		7.06
Sulphuric acid, - -	2.16		7.30

There exists a striking identity in the composition of buckwheat and rye. In the seeds of the former there is 27 per cent. of husk. The 73 per cent. of flour, closely resembling that of rye in color and properties, contains 10½ of gluten, and 52 of ordinary starch. The greatest resemblance also exists in the constitution of the ash when both plants have been grown on the same soil. The dried grain of rye contained 2.4 per cent., that of buckwheat 2.1 per cent. of ash.

335. Boussingault gives the following as contained in the grain (A,) and straw (B,)

	A	B
Water per cent,	12.5	11.6
Nitrogen per cent. of dried,	2.40	0.54
" " not dried,	2.10	0.48
Ammonia dried, calculated from the nitrogen,	2.94	0.65

336. Inorganic analysis of Buckwheat straw (*Sprengel*) 100,000 parts of the dry straw contained 3203 parts of ash:

Potash,	332
Soda,	62
Lime,	704
Magnesia,	1292
Alumina,	26
Oxide of iron,	15
Oxide of manganese,	32
Silica,	140
Chlorine,	95
Sulphuric acid,	217
Phosphoric acid,	288
	3,203

337. An acre of 28 bushels, weighing 56 lbs. per bushel, gives of the grain, an average of

Organic matter,	1326 lbs.
Ash,	22 "
Nitrogen,	32 "
Phosphoric acid,	11 "

338. Proximate organic analysis of Buckwheat: (*Salisbury.*)

Starch,	42.47
Sugar and extractive matter,	6.16
Dextrine and gum,	1.60
Epidermis,	14.42
A light gray matter insoluble in water and boiling alcohol,	10.10
Albumen,	6.70
Casein,	0.78
Matter dissolved out of the bodies insoluble in water, by boiling alcohol; rising with a substance analogous to water,	2.66
Oil,	0.47
Water,	12.88
	98.24

339. Buckwheat is used as food for man and animals, and is decidedly nutritious. Its fattening qualities are found in practice to be higher than could be supposed from analysis; and the meat formed by it is of peculiarly fine quality. The outer husk being hard, this grain should always be ground or cooked before feeding.

340. The uncrushed grain, and the fresh straw produce a remarkable and hitherto unexplained effect upon swine. If allowed to feed in a newly harvested buckwheat field, the head and ears are attacked by an eruption, with apparently intense itching, while the animal presents all the symptoms of intoxication. In severe cases death ensues. So, likewise, the fresh grain fed whole in large quantities, disorders the bowels; but if ground or cooked, these symptoms are not observed. In the latter case the husk is passed by the animal entirely undigested. Further investigation is necessary to explain these phenomena.

341. The straw is harsh, and not relished by horned cattle; but horses will eat all except the coarsest parts, and keep in good condition upon this alone. Buckwheat straw, unthrashed, and cut up is excellent fodder for working horses. It must be kept in a dry place, as it readily absorbs moisture, ferments, and spoils. If boiled, the straw will form a thick jelly.

342. Buckwheat is frequently sown for the purpose of plowing in as a green manure to precede the wheat crop. Though not equal to clover, it is yet beneficial to lands deficient in organic matter. It should be turned under when beginning to blossom.

343. The lighter class of soils is supposed to be the best for this grain, but it will prosper on any except the heaviest. Generally, the land receives but one plowing, and a light harrowing; from 2 to 3 pecks of seed to the acre are sown broadcast, and then well harrowed in. In the latitude of Michigan, about the 20th June, is the best time to sow; but we have known good crops to succeed barley, when the frosts were late.

344. In harvesting, the best mode is to cradle it; rake it

into small bundles, which are fastened by merely twisting the tops; and let it stand till dry. If cut with a scythe and left upon the ground, the seed is apt to shell out; the straw dries slowly; and much sand and dirt adhere to the grain. It should be thrashed at once as it is drawn into the barn, otherwise it will again absorb moisture, and heat. The best mode of thrashing is with horses, a machine being apt to break the grains. It must be cut before the whole is fully ripe.

345. The crop varies from 10 to 30 or 40 bushels; 20 to 25 being probably the average. It appears to depend much upon the state of the weather when in the fullest blossom.

346. The legal weight of a bushel of buckwheat in Michigan is 42 lbs.

347. MILLET. Under this name five plants of differing genera, which are cultivated for their seeds, are comprehended. They are all true grasses.

(A.) Common Millet, *Panicum miliaceum.*

(B.) Indian or Grand Millet, *Sorghum vulgare.*

(C.) Guinea Corn, *Sorghum cernuum.*

(D.) Bengal Grass, or Italian Millet, *Setaria italica.*

(E.) German Millet, *Setaria germanica.*

The first *(a,)* is most generally grown in the United States; the others being rarely met with. The second and third *(b)* and *(c,)* belong to the same family as Broom corn, (*Sorghum saccaratum.*) In other countries they are used as food for men and animals, and the straw or stalks as fodder.

The Indian Millet *(b,)* furnishes the bread of the Arabians and other people of the East, as well as of those of Africa. It is also eaten in Italy, Spain, South of Germany, and the West Indies. It matures perfectly in the neighborhood of Detroit. In its mode of growth it resembles Indian corn, but the seeds are different. In this country it is scarcely worth cultivating except as a curiosity, as it requires the same labor as corn, while its produce is smaller, and of an inferior quality.

348. As an article of food the Common Millet *(a,)* is very similar to rice. It does not appear to have been perfectly analysed; but the following are given as the inorganic constituents of the grain grown at Giessen, Germany. (*Rolich.*)

Potash,	9.58
Soda,	1.31
Magnesia,	7.66
Lime,	0.86
Phosphoric acid,	18.19
Sulphuric acid,	0 35
Silica,	59.63
Peroxide of iron,	0.63
Chloride of sodium,	1.43

349. The soil required for this crop is dry, rich, and well pulverized, sandy, rather than clay. It should be deeply plowed, and well harrowed. If sown broadcast, half a bushel of seed is the proper quantity, but on rich ground a peck may prove sufficient. If drilled, 8 quarts of seed are enough. If intended as a fodder crop, more seed should be used, it being regulated in proportion to the richness and condition of the soil. It will do well on land that is too light for grass. The time for sowing in Michigan is from the 1st of May to the 1st of July, or even later if intended for soiling; June is the usual month in New York. After sowing, the field should be rolled. When intended for a grain crop, it must not be allowed to become entirely ripe, or much will be lost by shelling. It may be cradled and bound, or cut with a scythe and raked into bundles. In New York, as much as 2¾ tons of fodder, and 32½ bushels of seeds have been raised to the acre. As high as 60 to 80 bushels of seed per acre are said to have been produced. (*Allen.*) The usual crops are from 1 to 2 tons of straw, and 20 to 30 bushels of seed.

350. In the United States, Millet seed is never used for human food; but when ground into meal it is excellent for fattening animals. The chief use of Millet is to take the place

of hay when that is likely to fail; or to serve for soiling; for both which purposes it is admirably adapted. According to Boussingault, dry Millet straw contains 0.96 per cent. of nitrogen, and 147 lbs. of it are equal in nourishment to 100 lbs. of ordinary natural meadow hay. If intended for hay alone, it should be cut as soon as the head is formed, and treated like any other grass.

351. CANARY GRASS, *(Phalaris canariensis)* is rarely cultivated in the United States, and what is used among us for feeding tame birds (its only value) is chiefly imported. It is, however, well adapted for most parts of this country; and might, it is believed, be rendered profitable, if grown on a small scale. It is a native of the Canary Islands, but is now grown in the south of England, and other countries. It requires a rich, fine, loamy soil. The seeds are drilled about a foot a part, as early in spring as frosts will permit, at the rate of 4 to 5 gallons per acre. Afterwards, the space between the rows must be kept well worked with a shovel plow, or some similar implement, and perfectly free from weeds. It may be harvested, cured, and thrashed like any other grain. From 30 to 35 bushels per acre is the ordinary yield, and from that to 50 bushels per acre. The straw is rough and coarse, but may serve for winter fodder and bedding.

These are all the Cereal plants grown in the Northern United States for their seeds.

CHAPTER XII.

LEGUMINOUS PLANTS.—BEANS; PEAS; LENTILS; VETCHES; AND LUPINES.

352. This class of plants derives its name from the seeds producing *legumin*, a substance identical in composition with the *casein* (or cheese) of milk; corresponding with the *gluten* (or nitrogenous compound) of the cereals. It is formed of Oxygen, Hydrogen, Carbon, and Nitrogen, with Phosphate of Lime and Sulphur incorporated; but the exact quantities do not appear to be accurately ascertained. (*Carpenter.*)

353. Under this head several botanical genera are included, most of them natives of temperate climates; and there are many varieties produced by cultivation. The following may be enumerated as those chiefly used by man:

(A,) Common or English bean, including Field beans, Sow, Horse, Garden beans, &c.	*Faba vulgaris*
(B,) Kidney beans,	*Phaseolus vulgaris.*
(C,) Lima beans, with several other species and varieties.	*Phaseolus lunatus.*
(D,) Common lentil,	*Ervum lens.*
(E,) Bastard lentil,	*Ervum Ervilia.*
(F,) One flowered lentil,	*Ervum monanthos.*
(G,) Chick pea,	*Cicer arietinum.**
(H,) Common pea, with several species and varieties.	*Pisum sativum.*

* This long cultivated pea was found by Capt. Stansbury's party, growing wild in the Interior of Oregon, and in the valleys of the Utah, in sandy bottom land. (*Exploration, p.* 385.) It is a native of the South of Europe, and is grown in India under the name of *Gram*. It has always been supposed to require a hot climate.

(I,) Lupines,	*Lupinus albus.*
(J,) Tare or vetch, with several other species.	*Vicia sativa.*
(K,) Broad bean, windsor bean,	*Vicia faba.*

354. In the United States the cultivation of leguminous plants is chiefly confined to Kidney Beans *(b,)* and Peas *(h,)* some varieties of which prosper in every section of the country. In the census they are united together; and no account appears to have been taken of them before 1850. In that year the total crop was 9,219,975 bushels, or nearly double the quantity of barley grown. North Carolina produced the largest amount, viz: 1,584,252 bushels, while South Carolina, Georgia, and Mississippi, alone besides, produced each, over a million of bushels. The crop of Michigan was 74,254 bushels. In the Northern States, these crops may be considered as of inferior value.

355. As regards the analyses, it will be most convenient to class them all together; and we shall be obliged to depend chiefly on the labors of foreign chemists.

The following by Horsford and Krocker of Germany, and Thompson of Scotland are believed to be correct.

	Table Pea, Vienna.	Field Pea, Giessen.	Table Bean, Vienna.	Large White Bean, Giessen.	Lentils, Vienna.	Sow Bean, Scotland
Vegetable casein & albumen	28.02	29.18	28.54	29.31	30.46	29.43
Starch,	38.81	66.23	37.50	66.17	40.00	6[illegible].61
Gum,	28.50		29.20		25.06	
Ash,	3.18	2.79	4.38	4.01	2.60	3.96
Skin,	7.65	6.11	4.11	4.41	?	?
Moisture in the fresh seed.	13.43	19.50	13.41	15.80	13.01	10.60

From this table it appears that the nutritious qualities of each species is very nearly the same. The flesh-forming constituents are large, and there is sufficient starch for all the purposes of life, but little or nothing to form fat. Other analyses give from 1.5 to 2.1 per cent. of oil or fatty matter in beans, and from 1.9

to 2.7 per cent. in peas, probably in or immediately beneath the skin.

356. Ultimate analyses of White Peas, *(A,)* and Pea Straw *(B,)* *(Boussingault)* raised on manured land, yielding 16 bushels per acre, weighing 62 lbs. per bushel. One part of peas, after complete drying, weighed 0.914; one part of dried peas left of ash 0.0314. Of the straw, the acre produced 22 or 23 cwts. (of 112 lbs.) One part of the straw, after drying, weighed 0.802; one part of this left of ash 0.1132. And Scotch Beans, dried at 212 ° *(C.)* *(Thompson.)*

	A		B	C
	I	II		
Carbon, - -	46.06	46 94	45 80	45.59
Hydrogen, - -	6 09	6 24	5 00	
Oxygen, - -	40 53	39 50	35 57	
Nitrogen, - - -	4.18	4 18	2.31	4.61
Ash, - - -	3.14	3 14	11.32	3 96

10.60 per cent. of water was expelled from the Beans in the process of drying.

357. Inorganic analyses of leguminous plants:

	Will and Fresenius.	Bichon.	Bichon.	Levi.		Thompson.
	Pea.	Pea.	Sow Bean.	Bean.	Lentil.	Scotch Bean Meal.
Potash - - - -	39.51	34.09	20.82	38.89	34.31	23.15
Soda - - - -	3.98	12.76	19.06	11 78	13 30	9.42
Lime - - - -	5.91	2 46	7 26	5 90	6 24	5 18
Magnesia - - -	6.43	8 60	8 81	9 03	2 41	9 03
Oxide of iron - -	1.05	0.96	1 03	0.11	1 98	1 80
Phosphoric acid - -	34.50	34.57	37.94	31.34	35.82	35.26
Chloride of sodium -	3.71					
Chlorine - -		0.31	1.48	0 33	4.56	1.75
Sulphuric acid - -	4.91	3.56	1 34	2.47		1.29
Silica - - -		0.25	2.46	0.44	1.31	13.12

358. Inorganic analyses of Field Pea (A,) and Straw (B.) *(Prof. Way.)*

	A	B
Silica,	1.24	5.36
Phosphoric acid,	34.81	4 50
Sulphuric acid,	5.68	5 66
Carbonic acid,	1.82	14.74
Lime,	6 32	37.99
Magnesia,	6.57	6.73
Peroxide of iron,	0.59	1.76
Potash,	40.19	17.17
Soda,	0.65	2.48
Chloride of sodium,	0.68	3.57
Chloride of potassium,	1.42	

These analyses prove that pea straw is a peculiarly valuable fodder. According to Boussingault, dried pea straw contains 1.95 per cent. of nitrogen; and 64 lbs. of it, are equivalent for nourishment to 100 lbs. of ordinary hay, while 27 lbs. of white peas, and 25 lbs. of beans *(b,)* are equivalent to 100 lbs. of hay.

359. Nutritive matter derived from an imperial acre of pease, producing 25 bushels or 1600 lbs. *(Stephens.)*

Husk or woody fibre,	130 lbs.
Starch, gum, &c.,	800 "
Gluten,	380 "
Oil or fat,	34 "
Saline matter, or ash,	48 "

360. Sugar appears to be contained in only a few of the leguminous plants as in the *Sugar-pea ;* gum, on the contrary, mucus, and pectic acid, a wax-like substance, and the same salts as in the cereals, are constant ingredients in all. In the skins, particularly of lentils, tannin is found. A large quantity of potash and soda, and a larger proportion than usual of sulphuric acid, characterize their ashes. The *legumin* of the pea and bean differs from the gluten of wheat in being soluble in water, and in very dilute acid or alkaline solutions.

361. THE PEA most commonly cultivated in the Northern States, in fields, is the *Grey* or *Canada Pea, (Pisum arvense;)* but varieties of the *White Pea (P. Sativum,)* are also grown on a large scale. In Virginia and the States southwards

The Chickasaw Pea, *The Cow Pea*, *The Black-eyed Pea*, and others, unknown at the north, are in common use, where they are depended upon for pasture, as clover is with us.

362. The soil best adapted to this crop is a loam, a little inclining to clay, abounding in the alkalies. Barn yard manures, freshly applied, are injurious as forming much straw at the expense of the seed; but ashes, plaster, and lime, and *probably* guano, may be used with much benefit. Land habitually wet should not be sown with peas.

363. Unless the soil is very highly cultivated and very friable, plow in the fall, laying the furrows up high; and again, crossways in the spring, so soon as the earth is sufficiently dried. Harrow thoroughly, and *deeply*. The common quantity sown in New York is 1 to 1½ bushels per acre, but the Scotch use 4½ bushels; and in the United States, from 3 to 4 bushels are preferable to the smaller quantity. The goodness of the crop greatly depends upon the roots being so deeply buried that they are beyond the risk of the earth around them drying up in summer. To ensure this, as it is very difficult if not impossible to cover the seed evenly with a harrow, they should be plowed in with a wheat cultivator, so as to leave them from 2 to 2½ inches or more below the surface, and then the field should be well rolled.

364. Harvesting is effected with the scythe, the straw being rather torn up and rolled into heaps than cut; or when fully ripe, the roots may be easily and quickly pulled with a horse rake. Pease are then left on the ground till dry, and are either put away in the barn; or, as is preferable, thrashed as they are hauled in. This may be done with the flail, or horses, the latter being the most expeditious and cheapest. The bottom of the wagon should be tight to prevent waste.

365. In Virginia, peas are frequently grown among corn, being planted between the corn hills, and made at the expence of

very little additional tillage, other than what the corn alone would receive. After securing enough for seed, the pease are usually fed off the land to hogs, and in that way, are a very important auxiliary to the crop of corn: while the dung, and straw plowed in, manure the land for the next season.

366. In other southern States, the *Cow*, *Indian*, or *Stock Pea*, is much relied on for pasture, and as a fertilizer. It is sown broadcast, or in drills, or it is hoed in among corn, when the culture of the latter is finished. Under any circumstances, the pea is valuable as a green manure; but the cost of seed is too great, and the quantity of straw too small to render it popular for this purpose.

367. The great enemy of this vegetable, and one which discourages its more extended cultivation is the Pea-weevil, or Pea-bug, *(Bruchus Pisi.)*

After the pea-vines have flowered, and when the peas are just beginning to swell in the pod, the weevils deposite their eggs singly, in the pod, just above the pea, chiefly at night, or during cloudy weather. The grubs, as soon as hatched, penetrate into the pease; and in time bore a round hole from the centre to the hull, leaving the latter, and generally the germ of the future sprout untouched. The grub is changed to a pupa within its hole in the pea, in the autumn; and from November to the spring casts its skin again, becomes a beetle, and gnaws a hole through the thin hull in order to escape, which frequently does not happen before the pease are planted for an early crop. Pease containing this insect may be detected by a minute hole, and dimple. It may be killed by immersion in very hot water; but as the mischief is already done, and as the weevil lives on other plants, this process can be of little use.

These attacks may be escaped, it is said, by sowing in the month of June, after the parent insect has ceased to deposite its eggs; but as the abundance of the crop appears to depend on a certain amount of rain or moisture while it is in blossom, and as great heat is injurious to it in its early growth, equal difficulties or risks exist in this attempt to find a remedy. Till lately, the district lying along the River Thames in Canada,

was free from the weevil, and a large portion of the peas consumed in the Northern States were imported thence, but this immunity is said to have passed away. According to Dr. Harris, the weevil, as late as 1852, was rare in New Hampshire, and still unknown in Maine.

"The crow-blackbird (*Quiscalus versicolor,*) is said to devour great numbers of these beetles in the spring; and the Baltimore Oriole, (*Icterus Baltimore.*) splits open the green pods for the sake of the grub contained in the pease, thereby contributing greatly to prevent the increase of these noxious insects. The instinct that enables this beautiful bird to detect the lurking grub, concealed as the latter is, within the pod and the hull of the pea, is worthy our highest admiration" (*Harris.*)

368. The Statutes of Michigan provide no standard weight for the bushel of pease. The average crop is from 20 to 25 bushels, but as high as 50 bushels per acre is not very uncommon.

369. Pease are frequently fed to hogs. As has been already perceived they possess little capability to fatten, but no food can be given which will form *flesh* more rapidly; and in this respect they are essentially useful. They should be either ground and cooked, or soaked and partially soured before feeding. If fed whole, they are apt to swell greatly in the stomach, and injure or even kill the animal; but if this does not occur, much will be passed undigested, therefore wasted. At present, ground pease are made into bread in Scotland and some other countries. Soup or gruel made of ground pease is an excellent food for calves.

It is customary, in some localities, to sow pease and oats together, for the purpose, afterwards, of feeding to horses The supposed benefit derived is the upholding of the pea, as it clings to the straw of the oat. We are inclined to think, however, that the oat will suffer as much or more from the overshadowing of the pea, as the pea gains from the protection of the oat; and prefer mixing the two afterwards as we require them.

In some soils, a heavy crop of pease proves beneficial in destroying weeds; and leaves the ground both clean and mellow. The roots of

this plant render the soil very friable; and in this respect are beneficial, mechanically, on adhesive clays.

370. BEANS. In the United States, the English Bean, *(a,)* (which in that country takes so important a place in the rotation in clay soils,) does not prosper. Our climate appears to be either too hot or too dry for it. With us three species or varieties, belonging to the genus *Phaseolus (b,)* are commonly grown as a field crop, the *large white bean, the small white bean*, and *the China bean*, the latter having a spot of deep red upon it. Some 30 other varieties may be found in gardens—known as *climbing beans* and *bush beans;* and in France and England as *Harricot Beans.*

371. The above *(b,)* will grow well on any soil, but sandy or gravelly lands are generally preferred, both on account of their being more easily kept clean, and because upon them the seed is less apt to be damaged in case of rain when ripening. Upon clay and other retentive soils, the pods which lie upon the ground are easily injured and rotted when nearly ready to harvest. Upon sandy lands, also, the seeds ripen earlier and more evenly.

372. Beans may be grown in hills, in rows, or broadcast. The following is considered the best mode of culture, succeeding a hoed crop manured the previous season. Plough twice, and harrow well, or plow once, and render the surface fine with the cultivator, and roll. About the 1st June, plant in rows 22 inches apart,—either using a drill, or having marked out the rows with a *corn marker*,—at the rate of six beans to the foot. Hoe about the 26th of June, and again about the 16th of July; perfectly destroying the weeds. It is believed by the most skilful growers of this crop, that it is better not to plow, or otherwise disturb the ground, if the weeds can be kept down by hoeing. When the pods have turned yellow they are ready for harvesting, which is done by pulling the plants, and striking the roots against a stick held in the left hand, till they are clean;

the plants are then lightly stacked on the ground, rails or blocks of wood having been laid for the purpose. The stacks should not be so large that the sun-shine and wind cannot enter. When entirely dry, they should be hauled, and immediately thrashed by flail, otherwise the pods will again absorb the moisture, and heat. The beans should be spread for a few days on the barn floor and occasionally turned until they are perfectly dry; as even, after thrashing, if thrown into too large a heap, they will be apt to mould.

373. The following is an account of the expense of raising a crop of one acre as above, in Jefferson county, N. Y., in 1851. The kind used was the "small early Vermont Bean."

Plowing, harrowing and working, - -	$1.75
Planting by hand, - - -	75
First hoeing, - - -	1 13
Second hoeing, - - -	3.09
Pulling and stacking, - - -	2.40
Drawing, thrashing, cleaning, and measuring, -	1.75
One bushel of beans for seed, - -	1.00
Board, - - - -	2.50
Interest on land, - - -	3 50
	$17.87

VALUE OF CROP.

34 2-32 bushels beans at $1.00, - -	34.06
One ton of straw, &c., - - -	5 00
	$39 06
Deduct expences, - - -	17.87
Net proceeds per acre, - - -	$21.19

374. The crop varies from 15 to 40 bushels. As high as 60 bushels is said to have been raised to the acre in New York. Of late years, the supply has rarely proved commensurate with the demand.

375. The straw is eaten by horned cattle and sheep. For the last it is, in common with pease and pea straw, particularly

excellent in consequence of the large amount of sulphur which it contains—this being an important element in wool.

376. LENTILS are rarely or never cultivated in the United States except as a garden plant. The seed has been distributed (1853) by the Patent Office; and in this manner this useful esculent may become better known. In the south of Europe and in Asia it enters largely into the food of the people. There are several varieties of it, distinguished by the color of their seeds, the greater or smaller growth of their stems, and the earliness of their period of ripening.

377. The Lentil requires a somewhat light soil and warmth. It is greatly less productive of straw than the pea and the bean, and the produce of seed is also comparatively small. There could be no benefit in introducing it into field-culture in this country. In gardens, it may be cultivated as peas are.

378. The TARE or VETCH is largely grown in Great Britain as a forage-plant, for which purpose it is much esteemed. In the United States it does not appear to be usually cultivated, though it will prosper in the northern States. There are several species and varieties; and in situations where grass is deficient, and regular rotations of crops are employed; or where grass fails early in the season, as on many of the Prairies, this crop would prove beneficial. All animals are fond of it, and all thrive on it in an eminent degree. Hogs may be fattened entirely on it. It causes milch cows to give more butter than any species of green food; and horses can be kept fat on it.

379. In Europe it is sown both in autumn and in spring, but in our Northern States, it would necessarily be a spring crop only. It requires land in good condition and free from weeds. In Scotland, manure is always given it, and the land is well worked. It possesses the advantage of growing on all classes of soils. It is *generally* sown broadcast, at the rate of 3 to 4 bushels per acre; but oats are frequently mixed with it, when

$1\frac{1}{2}$ to 2 bushels of Tares, and 1 bushel of oats are enough. Light or poor soils require more seed. The *Hopetown*, or *White-flowered Tare*, is considered the most valuable variety. When intended for fodder, Tares are usually cut and fed to stock in stables or yards. If intended for seed they may be treated as pease, being cut with a scythe. If fodder is wished for, sowing should take place in rotation: and the plant be used after the pods are formed, but long before the seeds become ripe.

380. LUPINES are grown with us as a garden flower, but in Italy are used both as food, and to plow under as a green manure, a practice derived from the ancient Romans. The flavor is said to be coarse and bitter. They flourish in light sandy lands, but can be of no value to us.

CHAPTER XIII.

GRASSES AND OTHER FODDER PLANTS.

381. As the production of domestic animals, and manure depends on grasses, we consider these as next in importance. The Belgians have a proverb which should be written in letters of gold on every barn-door: "Without dung, no crops; without cattle, no dung; without grass, no cattle."

382. The botanical family of Grasses (*Gramineæ*,) is extremely numerous; there are few parts of the world where some species are not found growing wild; while in moderate climates they form the great mass of vegetable production. In Agriculture, they are usually divided into (*a*,) wild grasses, and (*b*,) cultivated or tame grasses. These latter (*b*,) are grasses of peculiar value, which are regularly sown; while the former (*a*,) spring up naturally where they are found, without sowing. With very few exceptions, grasses do not change into varieties by cultivation, like other plants, but remain the same as when wild. In England, over thirty distinct species are employed for different soils and purposes. In the United States, not more than half a dozen, at the utmost, are usually sown, though we have a great variety of wild species. *Seventy-two* have already been detected in Michigan, without counting those that have been introduced. The culture of hay, at present, is principally confined to the Eastern, Middle, and Western States, from which the Southern markets are mainly supplied, in the form of pressed packages or bales.

The reason for using so many species of grasses as the English do,

(and in which respect it is very important that we should follow their example,) is that a greater weight can be produced on an acre; some are of temporary duration, some of permanent; the period of maturation differs, so that, when mixed, some are always in the best condition for pasture; the nutritive power differs; some are best adapted for pasture, others for meadow; and some prosper in one sort of soil, others in another sort. Mixed grasses are found to feed animals more profitably than one single kind; and it may be said, that the improvement of stock in Great Britain commenced, and has kept pace with the introduction of cultivated grasses, and other fodder plants. Great pains are taken in that country to find and cultivate the best species. In the United States we have been much too negligent in this respect.

In 1840, the hay crop of the United States was 10,248,108¾ tons; in 1850, 13,838,579 tons; in which, however, clover is included.

383. The following species are the most valuable:

(a,) Phleum pratense. Timothy, Herd's grass. (Meadow Cats-tail.*)

(b,) Agrostis vulgaris. Red Top, Herd's grass.

(c,) Agrostis alba. White Bent Grass, White Red Top, Fiorin. (Marsh Bent Grass.)

(d,) Muhlenbergia Mexicana. Fowl Meadow Grass.

(e,) Poa Pratensis. Green Meadow Grass, June Grass. (Smooth-stalked Meadow Grass.)

(f,) Poa compressa. Blue Grass.

(g,) Poa trivialis. Rough-stalked Meadow Grass.

(h,) Dactylis glomerata. Orchard Grass. (Rough Cocksfoot Grass.)

(i,) Lolium italicum. Italian Rye Grass.

(j,) Lolium perenne. Perennial Rye Grass, or (Darnel.)

(k,) Lolium annuum. Annual do

There is a species of Rye or Darnel grass (*Lolium temulentum,*) greatly resembling the Perennial, which is poisonous to every thing but hogs. It is naturalized in Massachusetts. In some parts of Europe it is a weed among wheat, and when eaten in flour is frequently fatal. (*Abstract of Med. Scien., June* 1851, p. 299.)

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*The last name within brackets in this list is that which is usually used by English writers. Those marked * belong to the South.

(*l*,) *Anthoxantham odoratum.* Sweet-scented Vernal Grass.
(*m*,) *Alopecurus pratensis.* Meadow Fox-Tail.
(*n*,) *Cynosurus cristatus.* Crested Dog's-Tail.
(*o*,) *Avena flavescens.* Yellow Oat Grass.
(*p*,) *Triticum dasystachyum.* Michigan Couch Grass.
(*q*,) *Phalaris Americana.* Ribbon Grass.
(*r*,) *Festuca elatior.* Tall Fescue Grass.
(*s*,) *Festuca pratensis.* Meadow do.
(*t*,) *Tripsacum dactyloides.* Gama Grass.*
(*u*,) *Sorghum halpense.* Guined or Egyptian Grass.*
(*v*,) *Cynodon dactylon.* Bermuda Grass.*
(*w*,) Grama.*

Besides these there are several species of *Poa* and *Festuca* that are valuable for pasture. When the subject is better investigated, undoubtedly many indigenous grasses will be added to the list, especially from California.

384. We will notice, in as small a space as possible, the peculiarities of these grasses: (*a*,) is a native of both Europe and the United States. It may be found growing wild in the counties of Ingham, Clinton, Shiawassee, &c., in Michigan, upon certain loamy clay soils, in great luxuriance, and it is known to spring up, without sowing, on clearing off the woods, and plowing. It is the most generally cultivated grass for dry soils in the United States, affording 1½ to 2½ tons of dry hay per acre; and in favorable situations remains permanently for very many years. It abounds in seed, which is easily saved, yielding from 10 to 34 bushels per acre. (*Wiggins.*) To save the seed, allow it nearly to ripen; mow; bind and shock like wheat, and thrash with horses. With a proper fanning mill, the seed can be perfectly cleaned, as readily as that of any of the cereals. According to Mr. Sinclair,* the nutritive value is double when ripe compared with the period

*A few years since a very extensive examination of the nutritive value of the English grasses was made by George Sinclair, under the direction of the Duke of Bedford at his estate of Woburn; and the results were published in an octavo volume, with colored copperplate engravings of most of the grasses, under the name of *Hortus Gramineus Woburnensis.* The work is now very difficult to obtain. The only copy we have seen in America is in the library of the Patent Office, Washington. Much interesting information was collected by Mr. S., but his labors are of less value than they ought to have been from his want of skill as an analyst, and his ignorance of the principles of nutrition. As, however, no one has gone over the same ground, his book is often quoted and referred to. The chief results will be found tabulated in *Allen's Amer. Farm Book*, p. 110.

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of flowering, while the weight is the same. The ripe crop exceeds the flowering in value as 14 to 5. It is usually sown with wheat in the fall, or with oats or barley in spring—the latter being preferable—and red clover is generally mixed with it. If sown alone, half a bushel of seed, or if with clover 12 quarts of grass, and one pound of clover is the proper quantity. Many persons sow less than this, but there is no economy is stinting grass seed. There should be enough to form a thick sod the first season. In heavy clays even more seed may be requisite. Timothy may be cut in the morning, and hauled into sheds or barns the same afternoon, using a bucket full of salt to each ton; but if stacked, it must be drier. The faults of this grass are: 1, the coarse stem and head. 2. The deficiency of leaf. 3. The small quantity of the after crop; and 4, the dying out of the plant in winter in certain classes of soils. It is better adapted for horses and neat cattle than for sheep, and compares badly with the fine, leafy hay of the English meadows. It is well adapted for mixing with other grasses. (*b*) and (*c*) Both belong to wet or marshy lands, and will not prosper in entirely dry soils; they can, therefore, scarcely be called cultivated grasses, though they are often sown in such situations. They are natives of the United States. They have creeping roots or *stolons*, and are very difficult to eradicate. The two greatly resemble each other, but the latter has white instead of red heads or flowers. In England, they are not held in much estimation. With us they are placed as hay, by many persons, on a level with Timothy, and for sheep they probably surpass it, the stalks being fine, and the leaf abundant. They afford good pasture, and grow rapidly after being cut or grazed. The latter species (*c*,) is called *Fowl Meadow grass* in many parts of New York, a name which has led to much confusion. If sown in marshes, they readily exterminate the coarser grasses and weeds, and form a productive meadow. About one bushel of seed to the acre should be used, or two bushels if sown on clean plowed land. About 1½ tons to the acre of dry hay is the usual product, the grass diminishing greatly in weight after cutting. (*d*,) Till lately, this grass has only been sown in Massachusetts, where it is also called *Duck-grass*, and *Swamp-wire-grass*, but it is now getting into general favor. It is mentioned by the Rev. J. Eliot, of Connecticut, as early as 1751, from whom we learn that it was supposed to have been brought into a poor piece of meadow in Dedham, Mass., by ducks and other wild water-fowls, and therefore called by such an odd name. There can be little doubt, however, that it is indigenous to Michigan where it is frequently met with in swamps. It grows tall and thick, and makes a soft and pliable hay. One good quality is that it does not spoil by standing

after it is ripe, but may be cut any time from July to October. It is represented as yielding heavy crops; grows about three feet high; and is essentially fine in the stalk with abundance of leaf, flower, and seed. Indeed, it appears to be the best American grass for damp soils yet known, and is worthy of very extensive culture. It is found to succeed best in *drained* marshes, which can be overflowed for two or three weeks in the spring and winter. When sown in such situations the land should be plowed, and between two and three bushels of seed harrowed in, with or without a grain crop. It may, however, be sown in lands too wet to plow, though yielding in such places an inferior crop; and it would be well to mix the two last species (*b*) and (*c*) with it. (*Dr. H. Wheatland in Farmer's Companion*, vol. ii, p. 5.) (*e*,) Is or has been abundant in all the Northern States, coming up immediately after the forests have been cut down, though it is now said to fail in the older Eastern States. It belongs to dry soils, and forms a thick, though shallow sod, and excellent pasture, especially for sheep. In heavy timbered clay soils it is generally mixed with the indigenous white clover. (*Trifolium repens.*) The stalks or culms are short and naked, the leaves reclining partially on the ground, and it is only when peculiarly luxuriant that it is worth cutting for hay. It is found, however, in all old meadows where the soil is adapted to it. It is rarely, if ever, sown, though the seed may be collected without difficulty. It dries up after flowering in June, but in the damp climate of England, it appears to grow more luxuriantly. "At the time of flowering, the produce on an acre is 10,209 lbs., when ripe 8,507 lbs., and the lattermath (*aftergrass*) is 4,083 lbs., and bears nearly an equal value with the ripe crop."

(*f*,) Is the well known *Kentucky Blue Grass*, so famous as pasture. It much resembles the last, but is of a deep color, with a bluish hue, and is better adapted for making hay. The late Hon. Henry Clay informed the writer that when he first went to Lexington, Ky., that county was covered with cane-brakes, the trees standing at distant intervals; and as soon as the cane was destroyed the blue-grass appeared. It is said to be confined to a peculiar geological formation, one of the lower lime-rocks of the great western coal field; and that the underlying rocks can be distinctly traced both in Kentucky and Ohio by the existence of this grass. If this proves to be everywhere the case, as present circumstances incline us to believe, this grass must be considered as strictly local in its habitat. The seed may be purchased at the Cincinnati seed stores.

(*g*,) According to Prof. Gray, this grass is not a native of America,

though naturalized in some parts of the Eastern States. It resembles the June grass (*e.*) Donaldson in his *Treatise on Grasses* does not speak favorably of its productiveness in England, although it is sown among others for pastures. It requires a sheltered situation on damp clays and strong loamy soils, and is easily hurt by frosts.

(*h,*) This grass is also a native of England, but has become entirely naturalized in the Atlantic States. It belongs to dry soils, though it does well in moderately damp situations, and, in its native state, grows in clays and heavy loams. It prospers well in the neighborhood of Detroit, proving quite hardy, and is about a fortnight earlier in the spring than either *Timothy* or *June grass.* It is a large, strong, tall grass, with somewhat coarse culms, and abundance of leaf; but, unless annually pastured, it has a tendency to grow in clumps instead of covering the ground. This is corrected by grazing the meadow in spring and fall. It succeeds well under trees, (hence its American name,) and the leaf, when cut or eaten, continues to grow; unlike *Timothy,* which must throw up a new leaf. "The produce, when flowering, is 27,905 lbs., per acre; when ripe, 26,544 lbs., and the lattermath, 11,910 lbs." Under most circumstances, it is essentially a most valuable grass, and is much relished by all kind of stock. It is the favorite grass of the rich pastures around Dublin, Ireland. The aftergrass is very abundant, and does not seem to suffer from heat as much as our grasses. It should always be sown with other species, but it ripens about a fortnight before *Timothy.* The Balled Drop-seed grass, (*Muhlenbergia glomerata, Trin,*) somewhat resembles it, and might, we are inclined to think, be profitably sown with other species in wet places. The latter is a native of Michigan.

(*i,*) Undoubtedly stands at the head of all cultivated grasses for productiveness, for feeding qualities, and for hay, but like all the Rye grasses, it has a tendency, if allowed to seed, to impoverish the soil. It is probably a distinct species and not a mere variety. Compared with the common Rye grass, it arrives sooner at maturity; has a greater abundance of foliage, which is broader and of a lighter color; grows taller; spreads less on the ground; its spikes are longer; the seed is lighter, smaller, and less in quantity. It is preferred by cattle to any other grass. It grows through winter; is earlier in spring; does not suffer from heat; and continues growing luxuriantly till checked by frost. The *true* species is perennial, and prospers well in the neighborhood of Detroit. The great difficulty we have found with it, is that cattle, horses, and sheep are so fond of it, that when mixed with many other varieties they leave all the rest, and eat this grass deep into the

soil, thus destroying it. When not allowed to be pastured, it is very luxuriant, and makes excellent hay, generally seeding twice a year in this latitude. We are inclined to believe that the common and the annual species, have often been sold for the *Italian* in the United States, and indeed, it is said that it can only be procured pure from a few great seed-dealers in England. In that country, it is usually sown with red clover, at the rate of 1 to 3 bushels of grass seed, and 8 to 16 lbs., of clover seed to the acre. (*See Patent Office Reports*, 1845, pp. 373, 376; 1846, p. 258.)

(*j*,) Is more used in Great Britain for meadows on all kinds of soil, and mixed with other grasses in pastures, than any other species; (*k*,) resembles it in all respects with the exception that it is an annual, and therefore used in rotations, where one year's grass only is required. Experience has given them a very high reputation, and late analyses, it is said, have proved them to be the most nutritive of grasses. They are generally sown with the clovers at the same rate as the previous one (*i*). They would be found highly profitable in the wheat soils of Michigan to sow with clover; the clover not being diminished in quantity, while this excellent grass is added to it. They are gradually finding their way into favor in the Atlantic States, though their *appearance*, compared with *Timothy* is unfavorable to them. There are several improved varieties, as *Pacey's*, *Stickney's*, *Russel's*, &c. A late writer in the *Journal of the Highland Agricul. Society*, (October, 1853, p. 111,) mentions the following objections to the Perennial Rye grass, (*j*) "Its growth is much stunted by being cropped or cut over; it is impatient of drought; it throws out few roots or radicle leaves; it covers the land during summer with dry innutritious herbage." These objections, which are probably exaggerated, do not apply to the Italian species.

(*l*,) Is chiefly valuable as pasture, the leaf being short, and the rich perfume being lost when the grass is ripe or dried. It is to this that the English meadows owe their well known odor; and the butter made in Delaware County, Pennsylvania, (where this grass has long been naturalized,) its excellent flavor. It prospers well in the neighborhood of Detroit, though it is a native of Great Britain. It is there considered the earliest of all the grasses, and succeeds best in moist localities, such as rich deep loams, but not in *wet* soils. Its owes its peculiar scent to an aromatic essential oil of which *benzoic acid* is the base. The same flavor may be imparted to butter, by giving the cows 20 to 30 grains of *Benzoin* twice a day, previously dissolved in hot water, and mixed with meal. This should constitute a part of all mixtures of grass seeds, intended for permament pastures. The seed is difficult to pro-

cure, and therefore expensive, but it is found that in Pennsylvania, when once it is rooted, it is only exterminated by the plow. (*See Patent Office Report*, 1849, p. 373.) With the writer, in a very rich damp loam, the culm grows fully three feet high.

(*m*,) Is held to be the best permament meadow grass in England, for rich lands. It so greatly resembles *Timothy* that it is difficult to distinguish it when not in blossom, but it affords much more leaf, the culm is finer, and the aftergrowth heavier. We have found the winters too cold for it in Michigan, and would not recommend it in this latitude.

(*n*,) Is also an English grass, of second rate value, and has proved too tender for this climate. Where it prospers it is chiefly valuable for pasture.

(*o*.) The same remarks will apply to this. (*p*,) Our experience with this has been accidental, it having appeared in the corner of a permament meadow, and spread over a large space, exterminating all the other grasses. It is an early, rich growing species, with great abundance of leaf, stalk and seed, makes excellent hay, and cattle of all kinds prefer it to *Timothy*. We mention it here that more experiments may be made with it. Should it not prove difficult to exterminate, like the English Couch grass, we know no native species that has more to recommend it on clay soils. (*q*,) This, known as the *Ribbon-grass* of the Gardens, prospers luxuriantly in wet marshes, soon covering them over, and forming a dry elastic surface. After a few years, the leaf assumes one color. Horned cattle eat it, but horses do not appear to like it. It may be planted, by throwing roots into the water, at a foot or two distance from each other. The seed appears to be barren, and it is subject to a species of *Ergot*. Mr. Allen failed to make it prosper on a clay marsh in New York. (*r*) and (*s*.) Prof. Gray, supposes these grasses to be naturalized from Great Britain, and that the latter is probably a mere variety of the former, but a more valuable grass. They prosper best in moist or boggy alluvial soils, but are of little general interest in this country. Of the Southern grasses we know nothing personally. The best accounts of them will be found in various volumes of the *Patent Office Reports*.*

*Since writing the above, a communication has been received from J. M. McAllister, Esqr., Summerville, Cass Co., Michigan, who has experimented upon a great variety of native and foreign grasses. He finds *Orchard grass* peculiarly valuable; but the most important that he has met with, is *Randal Grass*, the seed of which was received from Virginia. He has succeeded in introducing this extensively into Cass and the neighboring counties. (*See Farmer's Companion*, vol. iii, p. 30.) The seed resembles that of the Rye Grass; the living plant we have not seen, and do not know the botanical name.

The *Tussac Grass*, from the Falkland Islands; and the *Pampas Grass*, from the Prairies of South America, have been introduced, the first into Ireland, and the latter into Scotland, with great promise of success. There is little doubt but that they would be found valuable in our Southern and Middle States. They are both remarkable for their feeding qualities. It is believed that the *Tussac Grass* requires the neighborhood of the Sea; or at least, of salt springs.

385. As regards the ANALYSIS of grasses, little seems yet to have been done with accuracy. *Perennial and Italian Rye Grass* have been carefully examined by *Thompson* and *Way;* but with this exception we have no means of ascertaining what species are included under the terms "Hay" and "Grass," analyzed by the various chemists; while the probability is that each grass differs in its constituents, in its amount of nitrogen, and in the peculiar salts which it requires; and, likewise, according to the soil and climate in which it is grown. The English meadow hay is usually formed of 20 or 30 species, besides clovers; of the German we have no particulars. Mr. Norton gives the following "average of organic substances in Meadow Hay, from Boussingault and Johnston," but thinks the amount of nutritive matter too high.

Water,	16	Nitrogenous substances,	7
Starch,	4	Oil,	3
Gum and sugar,	12	Woody fibre,	50
Ash,	8		

386. Thompson gives the following analysis "of almost entirely Rye grass, *(Lolium perenne.")*

Water,	75
Soluble Salts, Silica and Insoluble Salts,	1.34
Organic matter,	23.66

Or reducing the same to its ultimate constituents, when fresh (A,) and dried at 212 ° F. (B,) together with hay made at Giessen, *(Dr. Will;)* species of grass not mentioned (C;) and hay grown in the neighborhood of Strasburg, France, *(Boussingault;)* species not mentioned (D):—

	A.	B.	C.	D.
Carbon,	11.35	45.41	45.87	45.80
Hydrogen,	1.48	5.93	5.76	5.00
Nitrogen,	0.46	1.84	41.55	1.50
Oxygen,	10.39	41.54		38.70
Ash,	1.32	5.28	6.82	9.00
Water,	75.00			

Thompson found the amount of solid matter in this grass to vary from 18 to upwards of 30 per cent, according to the early or late period of growth. When grass first springs above the surface of the earth the principal constituent of its early blades is water, the amount of solid matter being comparatively trifling; as it grows, the deposition of a more indurated form of carbon gradually becomes more considerable; the sugar and soluble matter at first increasing, then gradually diminishing, to give way to the deposition of woody substance.

Table of Rye grass before and after ripening.

	18th June.	23d June.	13th July.
Water,	76.19	81.23	69.00
Solid matter,	23.81	18.77	31.00

These are important facts; for if the sugar be an important element of the food of animals, then the farmer should cut grass for the purpose of hay-making at that period when the largest amount of matter soluble in water is contained in it. This is at an earlier period of its growth than when it has shot into seed, for it is then that woody matter predominates—a substance totally insoluble in water, and therefore less calculated to serve as food to animals than substances capable of assuming a soluble condition. This is the first point for consideration in making hay, since it ought to be the object of the farmer to preserve the hay for winter use in the condition most resembling the grass in its highest state of perfection.

100 parts of the stem and seeds of Rye grass when dried as hay, gave:

	Stem.	Stem.	Seed.
Water,	15.50	19.30	11.376
Organic matter,	79 52	75.72	82.548
Ash,	4.98	4.98	6.070

387. Inorganic constituents of Rye Grass *(Lolium Perenne,)* Stem, (A,) and seed (B,) *(Thompson,)* and Italian Rye Grass *(L. italicum,)* in flower, (C,) and in seed (D.) *(Way.)*

	A.	B.	C.	D.
Silica,	64.57	43.28	59.18	60.6
Phosphoric acid,	12.51	16.89	6.34	6.3
Sulphuric acid,		3.12	2.82	1.3
Chlorine,		trace.	2.27*	5.6*
Carbonic acid,		3.61		
Magnesia,	4.01	5.31	2.23	2.6
Lime,	6.50	18.55	9.95	12.3
Peroxide of iron, &c.,	0.36	2.10	0.78	0.3
Potash,	8.03	5.80	12.45	10.8
Soda,	2.17	1.38	3.98	0.1

Thompson observes "There is no doubt that these numbers undergo very considerable modifications on different soils." The seed tends to remove a larger portion of phosphoric acid from the soil than the stem; the quantity of acid found in the seed exceeding that in the stem by one-fourth. The same remark applies to the lime. The quantity of alkalies is twice as great in the stem as in the seed, while the total ash of the seed is a sixth part superior in amount to that of the stem.

388. According to Boussingault, 10,000 parts good meadow hay (species not mentioned) contain 547 parts of inorganic matter, consisting of:

Potash,	130
Soda,	10
Lime,	107
Magnesia,	43
Oxide of iron,	5

*Chloride of Sodium. The amount of this is remarkable, and *may* be the reason why cattle are so fond of this grass.

Silica,	189
Sulphuric acid,	16
Phosphoric acid,	32
Chlorine,	15
	547

The Nitrogen amounts to 1.65 equal to 2 per cent of Ammonia; the fat, wax, or oil to 3.8; and the starch, gum, dextrine, and pectine to 50 per cent, the rest being woody fibre and waste.

389. Liebig gives the following summary analysis of "Hay:"

100 parts of hay dried in the air contain 86 of dry matter.
14 of water.
100

100 parts of hay dried at 212° F.=116.2 dried in air contain:

Carbon,	45.8
Hydrogen.	5.0
Oxygen,	38.7
Nitrogen,	1.5
Ashes,	9.0
	100.0

100 lbs. of hay dried at the ordinary temperature contain 1.29 nitrogen.

240 oz. of such hay=15 lbs. contain 3.095 oz. of nitrogen.
72 oz. of oats, =4½ lbs. contain 1.34 oz. of nitrogen.
4.435

390. Prof. Way has given the water (A,) and flesh forming constituents (B,) of the following grasses, in 100 parts.

	A.	B.
Sweet-scented Vernal grass,	80.35	2.05
Orchard grass,	70	4.06
Meadow barley,	58.85	4.59
Timothy,	57.21	4.86

391. The following principles may be laid down. *(a,)* The proportion of soluble matter yielded by any species of grass, when made into hay, varies not only with the age of the grasses, when cut, but with the soil, the climate, the season, the rapidity of growth, the variety of seed sown, and with many other circumstances which are susceptable of constant variation. *(b,)*

Animals have the power of digesting a greater or less proportion of that part of their food which is insoluble in water. Even the woody fibre of the hay is not entirely useless as an article of nourishment. *(c,)* The most valuable constituents of the grass, such as the albumen, casein, starch, sugar, &c., may undergo great and ruinous change by fermentation and washing before and after the hay is put in stack or barn; so that ill-made hay, exposed to rain, may be inferior in nutritive quality to the coarsest straw. *(d,)* The riper the straw or grass, the less soluble matter does it contain; and soil, season, and manure will equally affect the quality of hay. One field will grow a hard wiry grass, while another will produce a soft and flexible plant, and highly nutritious hay. In England, a much higher price is given for hay cut off old grass fields, than for the first crop grown; and race and hunting horses are fed on hay over a year old, new hay injuring their *wind* and condition. *(e,)* Thompson found that the soluble matter of hay capable of being taken up by cold water, was as much as 5 per cent, or nearly a third of the whole soluble matter in hay. Thence we may form some notion of the injury liable to be produced by every shower of rain which drenches the fields during hay harvest. But hot water will extract over 16 per cent. of soluble matter; and if we consider the warmth of the soil and hay, and also of the rain in summer, the loss in this country is probably much greater than 5 per cent. *(f,)* The *bleaching* of hay is owing to the loss of wax, as much as 2 per cent of which may readily disappear. But this wax is important for fattening; and *bleached* hay is decidedly deteriorated in feeding qualities. In Scotland 100 parts of hay were found to be equivalent to 387½ parts of grass; or it requires nearly eight tons of grass to yield two tons of hay to the acre. By late analyses at the Royal Agricultural College, Cirencester, England, *Italian Rye Grass* was found to contain:

Water (in natural or green state,) - - -	80.770

Nitrogenized, or flesh-forming matters, - -	natural state, - -	2.861
	dried at 212° F. -	14.87
Non-nitrogenous, or heat and fat-forming matters, - -	natural state, - -	14.389
	dried at 212° F. -	75.09
Inorganic matter or ash, -	natural state, - -	1.980
	dried at 212° F. -	10.04

In making hay for our own use, but more especially in purchasing hay, all these points must be taken into consideration. A load of hay, before seeding, carefully dried, not exposed to rain or heavy dews, put by in sheds with salt so that fermentation is impossible, bears a much higher *intrinsic* and therefore *money* value than hay carlessly made, on which rain has fallen, and which has been stacked damp. A *spirituous* smell is not uncommon in stacks, which shows that the sugar is lost, and with it, probably, most of, or all the nitrogenous constituents. Such hay as we have mentioned last, is probably inferior in value to well saved oat straw. To be a good judge of hay, requires both much experience, and the consideration of many particulars; while the difference in nutritive qualities between good and bad samples—frequently resembling each other to the eye—is very great. Old hay, that is, hay which is over a year old, other things being equal, is always the most valuable. Some chemical change takes place by which it is supposed to be rendered more nutritive; and as has been already stated, horses prosper better upon it. The same peculiarity is found in grasses when used for pasture. It has been noticed, in the valley of the Kennet, England, that sheep might safely be fed upon, or soiled with the grass of the *first* crop of the water-meadows, but it was dangerous to do either with the *second* crop of the same grass, (*C. W. Johnson.*) Prof. Way analysed the grass of such meadows taken April 30th (A,) and 26th June (B,) and found that in 100 parts in a green state there were contained:

	A.	B.
Water, - -	87.58	74.53
Nitrogenous matter, - -	3.22	2.78
Fatty matter, - -	0.81	0.52
Starch, gum, sugar, &c., - -	3.98	11.17
Woody Fibre, - -	3.13	8.76
Ash, - - -	1.28	2.24

This not only shows that the very season at which grass is cut or fed is a matter of importance, but elucidates a beautiful provision of nature. In spring, growth is provided for, and heat or fat is not requisite, but in order to provide for the cold of winter, the later grass abounds in fat forming constituents, so that a provision may be laid up for the inclement season.

392. Grasses prosper, on the great majority of soils,—not on all—but those containing a fair proportion of clay and loam, with moisture, are the most profitable both for meadow and grazing.

393. A field laid down to grass for a length of time improves the soil for grain crops,—much if pastured, partially if mowed.

394. The manures requisite for grasses, necessarily vary with the needs of the soil, which can only be ascertained by analysis; but these plants peculiarly require the alkalies in the form of soluble silicates, the phosphates of magnesia, and lime, with nitrogen. Unleached wood-ashes contain the silicate of potash in the same proportion as straw, besides several other important salts, and consequently are an excellent manure for this crop. Barn-yard manures may also be applied with profit, but they are generally preferred in the shape of *composts.* Guano, plaster, &c., are found profitable in some localities. Salt is highly beneficial in some soils,—2 to 3 bushels per acre sown in spring. In England, nitrate of soda *(Saltpetre,)* at the cost of $6.00 per acre, has been used with profit. If barn-yard manure is used, it should be hauled and evenly spread on all lands containing clay, soon after the hay is taken off; on sandy lands, in spring. In both instances, harrow in spring, as soon the ground will bear the team without poaching, and mix the manure into the soil, till the whole looks black. There can be no injury done by tearing up the surface grass. If the sod is thin, sow on a little more seed and roll. By such a dressing of well-saved barn-yard manure every three years, a meadow may be kept in high condition. Such fields should not be pastured in spring, nor at any time when wet.

395. *Timothy* seed, in the United States, is usually sown with a grain crop; if with wheat in the fall or spring; with oats, or barley in spring. Barley is decidedly the best crop for the purpose. The first year's grass on the same field, one-half sown with oats, and half with barley, will show a very decided profit

in favor of the latter. In laying down a permanent meadow, the field should be well manured, plowed deeper than usual, and put in good condition in every way. In clay soils, finish putting in the grain crop, and harrow fine and evenly. Then sow the grass seed, and roll in, till the surface is smooth, and the clods entirely broken up. In such lands *Timothy* seed does not require to be deeply buried, and the same applies to clover when sown with it. In sand, give the grain one harrowing, sow the grass seed, harrow cross ways, and finish by rolling. In Great Britain, harrows made much lighter than the usual ones, with long, narrow teeth, placed rather near together, are used expressly for putting in grasses. In some cases a "brush harrow" is used for the same purpose. In very heavy soils, it is recommended to roll as soon as the grain-sowing is finished, sow the grass on the smooth surface, and finish with light harrowing.

To sow evenly requires some experience. The seed is caught between two fingers and the thumb, instead of the whole hand, and the casts are more frequent than in grain-sowing. There are machines, fastened by a strap to the sower's neck, for the purpose of sowing grass and clover seeds, which do the work well, and cost only a small sum. Weeds are often conveyed in grass seeds, and none but the perfectly clean should be purchased. Such will cost more at first but will be cheapest in the end. The *Journal of Agriculture* gives a table from actual experiment of the proper depth at which to sow these seeds. Fourteen species of grasses and clover were tried, and in all cases those on the surface, and not more than a quarter of an inch in depth sprouted the best; at 3 inches none at all appeared. In certain sandy and gravelly soils, however, grasses and clovers are apt to dry up in summer, if the roots are superficial. (*See Patent Office Reports*, 1846, p. 694.)

396. Under some circumstances, it is beneficial to steep such seeds previous to sowing, to strengthen and insure the germinating powers. The best mode of doing this, is to spread the

seeds on the barn floor, and shower over them gradually, with frequent turnings, as much water, at a time, as they can absorb without any running off. Do this for a whole day, at separate intervals, until they are thoroughly saturated. At night, make them up into a heap and cover with cloths so as to raise the temperature. Before sowing, spread out on a cloth to dry in the sun for a short time, so that they can be easily separated. Old or damaged seeds, incapable of germinating, are sometimes sold. This may be discovered by placing a piece of flannel at the bottom of a common saucer, saturating it with water, and sowing a few seeds on it. Keep in a warm place, renewing the water as it evaporates, and in three or four days all the seeds capable of germinating, will sprout. The same test may be applied to any kind of seed.

In Maine, the grain intended to be sown, is wet or soaked, the grass seed is mixed with the grain in this wet state, to which it readily adheres, and in this manner it is sown. We only mention this mode to condemn it; as either the grain must be buried too shallow, or the grass too deeply; in growing, the two will be apt to interfere; and the plants will be uneven.

397. These rules, with slight modifications which must be learnt from experience, will apply to all species of grasses. The small and light seeds are usually sold by the pound weight. The statutes of Michigan do not determine the weight of a bushel of Timothy seed, but 60 lbs. is the usual standard.

398. A great diversity of practice occurs as to the time when grass should be cut for hay. So far as can be ascertained by theory, the period at which grasses contain the largest proportion of nutritive matter is just previous to flowering, and while in blossom; but in practice, some species appear to be as good if not better when the seed is ripe. The question can only be determined by many carefully conducted experiments; and we trust that a matter of such great importance will not be allowed to remain in its present uncertain condition. Timothy cut

while in blossom, makes *dusty* hay, owing to the pollen; which is unpleasant, if not injurious to stabled animals.

Late experiments, very carefully made in Scotland, show that Italian and Perennial Rye grass, mixed hay, and clover, cut before flowering (*a*,) when in flower (*b*,) and when ripe (*c*,) fatten in unlike proportion, so as to be valued at (*a*,) 6d. per stone of 28 lbs., (*b*,) at 5½d., and (*c*,) at 5d. At the same time it was found that good oat straw was just as valuable as hay for fattening beef animals, when roots, oil-cake, &c., were given as the main food.

399. The more simple the operation of hay-making the better. The following plan has been followed for many years with complete success, the grass being pure Timothy, and Timothy, Red Clover, and June Grass mixed. If the meadows are extensive, begin mowing when first the heads appear. Do not cut till the dew is nearly or quite risen, leave till afternoon in swathe, rake into windrows with horse rake, and form into light cocks, each containing about one hundred pounds of *dry* hay; next morning, as soon as the dew is risen, throw these cocks open; and leave them so for a couple of hours, and then haul into sheds. Let a man stand with a bucket of salt, and scatter about half a handful on each large fork-full as it is packed away; using about an ordinary bucket-full of salt to a ton of hay. This is all that is necessary. The hay will come out in the winter nearly as soft and green as when put by; and will be eaten with avidity by the stock. If it is intended to be stacked, it had better stand the second day in cock, and be treated in the same manner as above on the third. If the grass has flowered, even this labor is not necessary. It may be cut in the morning, raked into windrows in the afternoon, and immediately hauled into sheds. By this rapid process, nothing is lost; the wax, the nitrogen, and the salts are saved; much labor is saved; and risk from rain and dew is not incurred; while the common salt prevents fermentation, souring, and the growth of the fungus so common on badly made hay, usually known as *mould* or *mustiness*, and which is so injurious to horses*

*The following passage contains much valuable practical matter, based on true

"Bad hay will change a horse's appearance in two days, even with an unlimited quantity of oats. The kidneys are excited by it to extraordinary activity. The urine, which in this disease is always perfectly transparent, is discharged very frequently and in copious profusion. The horse soon becomes hide-bound, emaciated, and feeble. His thirst is excessive. He never refuses water, and he drinks as if he would never give over. The disease does not produce death, but it renders the horse useless, and ruins the constitution. *Musty* hay is said "to be bad for the wind," and it is certainly so for every part of the body." (*Stephens.*)

400. Grass is cut with *(a,)* a scythe, or *(b,)* a mowing machine. It is raked with *(c,)* a hand-rake, or *(d,)* a horse rake, of which there are several kinds. It is pitched with a hay-fork, for which purpose the two-tined is generally preferred. The mowing-machine and the best horse-rake will cut and rake about 12 to 15 acres a day, under favorable circumstances, with four horses and two men. The same work to be done by hand would require about 18 men.

401. It is laid down as a principle, which appears to be strictly true, that hay can scarcely be injured by *its own juices alone*, but if wet with rain or heavy dews it requires very careful drying before being put away.

402. In hauling, three and sometimes four men are required.

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principles. "Damp hay, or even grass, may be stacked with layers of straw, or of old hay, sprinkled with salt to prevent heating, and to draw out the juice from the damp grass, which is then absorbed by the straw." [Rev. A. Huxtable, an eminent English Agriculturist, has long practiced this mode of putting hay by; and he finds that by so doing, not only does the grass require but little drying, but it so imparts its juices to the straw, as to render the latter still more valuable. The two are placed in layers, and in use are cut through, and mixed.] "Mouldy hay, put together with salt, from 8 lbs. to 25 lbs. per ton, was better relished by cattle, and did them more good than sound hay stacked without salt; of which many instances are recorded. (*Johnson on salt*, p. 105.) In Germany they even cure fresh cut grass by pitting with salt, 1 lb. to the 112 lbs.; it comes out quite a paste, and is said to go further as food than the same quantity of grass made into hay. When hay is packed with straw, the latter may vary from one-eighth to one-quarter, and the salt from 1 lb. to 3 lbs. per cwt., according to the dampness of the new hay. If old dry hay is used instead of straw, it must be in larger proportion because less absorbent. And where neither can be had, chaff might do, or even bran if salted enough to prevent fermentation." *Farmer's Magazine*, vol. iv, (1853) p. 280.

One stands on the wagon, one or two pitch to him, and one rakes the ground. It is not often, however, that the man on the wagon is able to stow it away as rapidly as two can pitch to him. Where hands are scarce, the raker is sometimes dispensed with, the hay-rake being run over the field when all is hauled. In changeable weather, no more should be cut in a day than can be well taken care of before night.

403. If sheds are used, the stowing away is very simple; one man standing on the load pitching, one inside catching and spreading the hay, and one salting and treading down. If stacked, the man on the stack requires experience, which can scarcely be taught by writing, so as to carry it up straight, of proper size and weight all round. An ill-made stack is very apt to fall over, or to let the wet into crevices and cracks. However, stacking is very deficient in economy. More or less hay is inevitably spoilt; and in winter it has either to be carried to to the barn to be consumed, exposing the remainder to wet, or the cattle, while feeding, are exposed to all vicissitudes of weather, waste much, and manure the ground, immediately around the stack, inordinately. It is calculated that a good shed, adapted for hay above, and for stock beneath, with proper racks, pays its own cost in three seasons, in saving alone.

404. There is a mode of increasing the yield of grass called *Gurneyism*, from its discoverer, the Hon. G. Gurney, of Cornwall, England. It consists of covering the field with 1¼ tons to the acre of straw, letting this lie for some time, and then raking it off. The grass is then cut or grazed, and the straw again returned. The principle on which this acts is unknown, but every one must have observed that grass covered with straw, or a bush grows more rapidly than when not covered. This mode does not appear to have been much used in England, and probably not at all in America. *(See Patent Office Reports*, 1846, p. 254,*)*

405. *Irrigation* of meadows is of high antiquity; and

greatly increases the yield. It requires the land to lie peculiarly in connection with running water, and a complex and artistic series of ditches and draining is necessary. It is too extensive a subject to enter upon in this work, though there are many positions in the United States where it may be favorably employed.

406. Good old hay is long and large, hard and tough; color inclining to green rather than to white, has a sweet taste and fragrant smell, and when infused in hot water produces a rich, dark-colored tea. In damp weather good hay absorbs moisture, and becomes heavier. "A truss" of good old hay weighs 56 lbs. (*Stephens.*) The following rule is given to find the weight of hay in bulk, but we have not tested it. It necessarily varies with circumstances, *old* hay weighing heavier per square foot than new; and ripe hay heavier than if cut before blossoming.

"Multiply the length, breadth, and height into each other, and if the hay is somewhat settled, ten solid yards will make a ton. Clover will require 11 to 12 such yards."

A peculiar mode of renovating worn out meadows has been employed of late years in Massachusetts. At the end of August or begining of September, the grass land is carefully and neatly plowed and rolled down. Fifteen to twenty loads of compost are next spread to the acre, and harrowed both ways. The grass seed is then sown and covered with a brush harrow, and is ready to cut the next summer, though perhaps a little later. The seed must be applied liberally, say three to four pecks per acre. (*Trans. of Agricul. Societies of Mass.*, 1852, p. 769.)

There are various other modes of renovating worn out meadows when it is not convenient to plow them, for which see *The Farmer's Companion and Horticultural Gazette*, vol. ii, (1853,) p. 20.

"In forming mixtures of grass seeds, every soil should be supplied with its appropriate mixture, both as regards succession and qualities; and as the permament ones require time to come to maturity, some of the more short lived should be introduced that there may be a crop from the begining, and also that there should be as great a variety as possible. The grasses thrive permamently only when mixed, some forming herbage in the spring and autumn, and a few throughout the warmer months; if they did not closely succeed each other, weeds would soon appear."

The following table, arranged by one of the large English Seed

Dealers, may prove practically valuable. This assortment of grasses, &c., is recommended as forming peculiarly excellent pasture. It were well if our American grains and grasses were tabulated in the same way. The number of seeds in an ounce are found by counting the number in a grain weight. The prices are given in English sterling, 5 shillings being rather more than one dollar—one penny to two cents.

Scientific names.	Price of seed in London. per bus.	per lb.	Average weight. per bush	Average number of seeds in one ounce.
	s. d.	s. d.	lbs.	
Lolium italicum, - -	6.0	0.6	15	27,000
Dactylis glomerata, -	4.0		11½	40,000
Trifolium pretense, -		0.6	64	16,000
Trifolium pratense perenne, -		0.7	64	16,000
Alopecurus pratensis, -	5.0	0.8	5½	76,000
Festuca pratensis, - -	6.0	0.6	13	26,000
——— duriuscula, -	6.0	0.6	9½	39,000
Poa nemoralis sempervirens, -		1.6	15½	133,000
Lotus corniculatus, -		6.0	62	28,000
Achillea Millefolium, - -		2.0	29¼	200,000
Lolium perenne, -	5.6	0.3	24	14,850
Trifolium repens, - -		0.6	65	32,000

CHAPTER XIV.

CLOVER (*Trifolium,*) AND OTHER FORAGE PLANTS.

407. Next to the Grasses, the Clovers are the most valuable as fodder plants. They belong to an entirely different botanical family, that of the *Leguminosæ, or Pulse Family*, and are known by the generic name *Trifolium* from *tree*, and *folium*, a leaf. Thence they are frequently called in English *Trefoils;* the leaves mostly presenting three lobes. Eight distinct species are found in the North United States; others again in the Southern States and California; and others in Europe. More than 160 species in all are enumerated by botanists. Nine species are cultivated in Great Britain; usually, only two in the Northern States of America. The following are the the most important:

(a,)	*Trifolium*	*pratense,*	Annual or Biennial Red Clover.*
(b,)	"	*pratense perenne,*	Perennial Red Clover, Cow grass.*
(c,)	"	*repens.*	Dutch or English White Clover.
(d,)	"	*repens,*	American White Clover.*
(e,)	"	*hybridum,*	Hybrid or Alsyke Clover.
(f,)	"	*minus.*	Lesser Yellow Trefoil,
(g,)	"	*procumbens,*	Low Hop Trefoil.
(h,)	"	*medium,*	Cow or Marl Grass, Southern

*Those marked * are either natives of America, or extensively naturalized.

			Clover, (?)*
(i,)	"	*incarnatum,*	Crimson Clover.
(j,)	"	*alexandrinum,*	Egyptian Clover.
(k,)	"	*arvense,*	Rabbit-foot Clover.*
(l,)	"	*reflexum,*	Buffalo Clover.*
(m,)	"	*agrarium,*	Hop Clover.*

Of the above, 4 are "Red" Clovers; 3 are "White;" 3 are "Yellow;" and the rest varying. (*b,*) (*h,*) and (*l,*) are in common use with us, the latter chiefly in the Western States where it is indigenous. We have distinguished between the "Dutch" and "American" White Clovers, which Botanists do not usually do, but having grown them side by side, we find them essentially different in habit; the first (*c,*) is a tall, strong growing plant, well adapted for meadows, standing frequently, when supported, 18 inches high; while the latter (*d,*) is short, adhering to the ground, and wholly unfit for meadows. If one is only a variety of the other, which appears probable, they are, economically, very distinct. The Dutch or English White Clover would be a valuable addition to our plants of this family. Attempts have been lately made to introduce into America the Alsyke Clover, (*e,*) and the seed has been distributed by the Patent Office. It is a native of the South of Europe, but has long been cultivated in Sweden and Germany, where it is very highly esteemed, and latterly in Great Britain. It is described as peculiarly luxuriant. The root is fibrous, and the heads globular. The stems are recumbent, but they do not root in the soil; "in short it may be described as a *giant* white clover, with flesh colored flowers." It yields two mowings annually. It will grow luxuriantly on poor, bare, obdurate clays as well as on light sands. It ripens its seed much earlier, and continues in vigor much longer than the Red Clovers. When once rooted it will remain for a great many years in full vigor, and produce annually a great quantity of herbage of excellent quality. A heavier crop of wheat is invariably produced after this than after other clover. The quantity of seed requisite is from 10 to 15 pounds per acre, while it will yield over two cwt. on the same area. It does not suffer from the severest frosts; it will flourish on barren land where few grasses will grow at all; and with it the soil never becomes "clover sick." (*Dr. Lindley.*) Such is its European reputation, and it is certainly worth trying extensively in this country. The seed in London is worth two shillings sterling—50 cents—per pound; and at that price might become with us an article of export.

The Crimson Clover (*i.*) is a native of the Southern and Central parts of Europe. It is an annual, and must be sown in autumn that it may flower and arrive at maturity in the following season. It has latterly attracted much attention in England. The Egyptian clover (*j.*) is also an annual. The other species are small, and unfit to be sown alone, but are commonly mixed by the English with grasses, for which purposes they are well adapted as varying the food, and filling up blank spaces. They would be profitable with us in permanent pastures.*

408. Red Clover prefers clayey soils; it generally thrives in good wheat lands; in light and sandy ground it gets bare and frosted. During its early growth it always requires the shelter of some other plant. It is apt to be lifted out of the ground and destroyed by frost in winter, if eaten bare, and not covered by snow. White Clover grows spontaneously in most clay soils, such as are known as "heavy timbered lands;" appearing as soon as the forest is removed. For sheep-pasture nothing can surpass it; but it is usually rather short for larger stock. It has a peculiar effect on horses in producing severe salivation when in blossom, but without apparently injuring the health or strength:—why, does not appear to be ascertained. This, we believe, has not been observed in the European variety.

409. The Red species are extensively grown throughout the Northern United States, chiefly, however, in the moderate climates. In wheat-culture, they are greatly depended upon as a sort of manure.

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*The difference between the annual Red Clover (*a,*) and Cow Grass (*h,*) is thus given by a late English writer. (*Farmer's Magazine*, vol. iii., 1853, p. 424.) "The first has a somewhat spindle shaped root, with but few fibres, grows more upright, has fewer hairs on the stem and leaves, thrives luxuriantly, stem generally hollow or pipey, broad leaves, and reddish-purple flowers; the latter has a somewhat creeping root, the stem grows zigzag and less globular than the other, and is solid or pithy, with a narrow leaf which, with the flowers, has a paler hue; it comes into flower from twelve to fourteen days later than the first." We do not remember ever meeting with the first in our Western States, where we are inclined to believe that our "large" species is the *Buffalo Clover*. It is, however, very difficult to distinguish the various species of this family. The California Clovers are spoken of as far surpassing any we at present cultivate in the Eastern portion of the continent.

410. Ultimate ANALYSIS of Red Clover (*a*?) (*Boussingault,*) one part of clover hay after complete desiccation weighed 0.790: one part of dried hay left, 0.078 of ash.

	I.	II.
Carbon, - -	47.53	47.19
Hydrogen, - - -	4.69	5.33
Oxygen, - -	57.96	37.66
Nitrogen, - - -	2.06	2.06
Ash, - -	7.76	7.76
	100.00	100.00

A surface of 120 square yards gave 44 lbs. roots, weighed after being thoroughly dried in the sun; when pulverized after drying in the stove the weight was reduced to 37 lbs. When perfectly dry one acre would furnish 1428 lbs. of residue. Composed as follows:

Carbon, - - -	43.4	per cent.
Hydrogen, - -	5.3	"
Oxygen, - - -	36.9	"
Nitrogen, - -	1.8	"
Salts and earth, - -	12.6	"
	100.00	

The same writer shows the amount of clover hay obtained from, and clover roots left in the soil of one acre with the elementary matter of the latter, which forms manure when plowed under, as follows:

Produce of hay per acre in 1839, - -	2292 lbs.
do dried at 212° F., - -	1810 lbs.
Roots dried in the sun, per acre, - -	1833 lbs.
do do at 110° F., - -	1418 lbs.
These roots consisted of, per acre,	
Carbon, - - -	615 lbs.
Hydrogen, - - -	75 lbs.
Oxygen, - - -	523 lbs.
Nitrogen, - - -	26 lbs.
Salts and earth, - - -	178 lbs.
	1417 lbs.

Thus returning, for the use of the next crop, only 204 lbs. of nitrogen and salts, per acre.

411. Prof. Way finds 100 parts of the following clovers in their fresh state, to contain of water (A,) and flesh forming principles (B.)

	A.	B.
Crimson clover, (*i*,)	82.14	2.96
Red clover, (*a*,)	81.06	4.27
Cow grass, (*h*,)	74.10	6.30
Sainfoin,	76.64	4.32

And Dr. Anderson, (*Trans. Highland Agricul. Society*, 1853, p. 509,) gives the amount of albuminous or flesh forming matters in the second crop of clover *hay* at 13.52 per cent.

Schwertz reckons that 2 cwt. (=224 lbs.) of green clover yield 48 lbs of hay. The relation of green to dry fodder varies with the age of the plant, and the meteorogical circumstances under which it has grown. At Bechelbronn 1 ton of clover in flower (second year,) afforded in hay 7 cwt.; 1 ton of clover in flower (first year,) afforded in hay 4 cwt. 2 qurs. 24 lbs. The average produce of this fodder reduced to hay was 41 cwt. (=112 lbs. per cwt.) 3 qurs. per acre. (*Boussingault.*)

412. Approximate composition of the green stems of Red Clover (A,) and White Clover (B.) (*Johnston.*)

	A.	B.
Water,	76.0	80.0
Starch,	1.4	1.0
Woody Fibre,	13.9	11.5
Sugar,	2.1	1.5
Albumen,	2.0	1.5
Extractive matter and gum,	3.5	3.4
Phosphate of Lime,	1.0	0.8
Wax and Resin,	0.1	0.2

413. Inorganic analysis of Red Clover; Broad Clover (A,) White Clover (B,) and Cow Grass, (*T. Medium*) (C.)

	Red Clover.			A.	B.	C.
	Boussingault.	Way.	Liebig.		Way.	
Carbonic acid,	25.0	16.9		23.47	18.0	25.51
Sulphuric acid,	2.5	4.2	1.1	1.85	7.2	1.08
Phosphoric acid,	6.3	6.3	4.1	6.71	11.5	5.41
Chlorine, &chloride of sodi'm	2.6	2.4	4.7		5.0	
Lime,	24.6	35.4	21.9	22.62	26.4	24.56
Magnesia,	6.3	11.2	8.3	4.08	8.2	4.52
Potash,	26.6	14.9	16.1	36.45	14 3	34.72
Soda,	0.5	1.4	40.7		3.7	
Silica,	5.3	3.3	2.6	0.59	3.7	0.63
Oxide of iron, &c.,	0.3	1.0	0.5.		2.0	
Chloride of potassium,		3.0				
Dried ash,				9.56		7.97

According to Sprengel, 100,000 parts of White clover in a fresh state contain 1735 parts of inorganic matter.

414. The following is a late comparative analysis of White clover (A,) Trefoil (B,) Red clover *(a,)* (C,) and Tares (D,) all grown on the same land in a natural condition, on the farm of the Royal Agricultural College, Cirencester, England. *(Dr. Voelcker.)*

	A.	B.	C.	D.
Water,	83.65	77.570	80.640	82.16
Nitrogenized matter capable of producing flesh,	4.52	4.481	3.606	3.56
Substances free from nitrogen capable of sustaining respiration.	10.26	15.949	13.784	12.74
Inorganic substances,	1.57	2.000	1.970	1.54

By " *Trefoil*" the context leads us to suppose that Hop clover (*T. procumbeus,*) (*a* is meant, but as the writer neglects to give the botanical name we cannot be sure.

415. The following tables, show the difference of the water and inorganic constituents of Red and White Clover hay, on different soils. *(Way.)*

	Red Clover.		White Clover.	
	Silicious Sand.	Clay.	Silicious Sand.	Clay.
Water,	13.97	12.20	12.60	12.00
Ash,	6.77	7.12	7.70	7.61
Ash calculated on the dry,	7.87	8.11	8.81	8.65

Composition of 100 parts of ash of Red and White Clover hay. *(Way.)*

	Red Clover.		White Clover.	
	Silicious Sand.	Clay.	Silicious Sand.	Clay.
Silica, - -	4.03	2.66	4.63	2.74
Phosphoric acid, - -	5.82	6.88	10.93	12.12
Sulphuric acid, -	3.91	4.46	7.05	7.38
Carbonic acid, - -	12.92	20.94	18.64	17.41
Lime, - -	35.02	35.76	26.32	26.51
Magnesia, - -	11.91	10.53	7.46	8.83
Peroxide of iron, -	0.98	0.95	1.17	2.76
Potash, - -	18.44	11.30	15.17	13.50
Soda, - -	2.79		3.03	4.41
Chloride of sodium, -	4.13	0.58	5.56	4.32
Chloride of potassium, - -		5.92		

416. Mineral matters contained in a ton of Red (A,) and White Clover (B,) hay. (In pounds and tenths.) *(Way.)*

	A.	B.
	lbs.	lbs.
Silica, - - -	5.2	6.3
Phosphoric acid, - - -	10.0	19.9
Sulphuric acid, - -	6.6	12.4
Lime, - - - -	55.6	45.5
Magnesia, - - -	17.7	14.0
Peroxide of iron, - - -	1.5	3.4
Potash, - - -	23.2	24.7
Soda, - - - -	2.2	6.4
Chloride of sodium, - -	3.7	8.5
Chloride of potassium, - -	4.7	
	128.4	141.1

417. As will be seen by these various analyses, the clovers are all peculiarly nutritious, containing everything that can be wanted for the growth and sustenance of an animal. The flesh and fat-forming constituents are large, and phosphate of lime, for the formation of bone predominates. The long tap-roots force them away deeply into the subsoil, the fibrous roots collect nutriment from the surface, and the large fleshy leaves, as

in all leguminous plants, are capable of absorbing such constituents as the air can afford. At the same time, if cut as hay, and carried off the ground, the clovers remove a comparatively large amount of valuable materials from the soil, and it is only owing to the fact that much of the material is collected in the subsoil, below the usual depth of the plow, and the roots of the cereals, that it does not become a *scourging* crop. As it is, it returns to the surface of the soil that which it has gathered from the subsoil, and which, under the ordinary system of cultivation would not have become available. Under a system of *thorough-draining*, which allows the roots of *all* plants to go to a great depth, many of the supposed advantages of clover as a manure would be lost.

418. From these analyses, also, we learn what manures are likely to be peculiarly advantageous; viz, such as contain nitrogen,—guano, barn-yard dung, urine, &c.; and such as contain the inorganic constituents—lime; phosphoric acid, in the shape of ground bones; sulphuric acid, in the shape of Plaster; Potash, as wood ashes; and soda, as common salt. Unless land contains a notable proportion of all these, Clover cannot prosper upon it.

419. Clover is always sown with some grain crops, and usually in the spring, as hard frosts are apt to injure the young plants. If with fall wheat, the seed is frequently sown upon the last snow in the spring, the covering which it receives from absorption being sufficient, or it may be harrowed and rolled. If sown with spring grain it should be treated as is recommended for grasses. The quantity of seed requisite, when unmixed, is from 10 to 18 lbs., according to the character, condition, and richness of the soil. Some persons steep the seed for twenty-four hours and roll it in plaster.

420. If intended for hay, it should be cut immediately after blossoming, and before the seed begins to form. The same

rule applies to the second crop. Seed is saved only from the second crop; and may be cut in the usual manner and thrashed, or the heads are pulled off by an implement for the purpose, and the hay left as pasture. Before thrashing, the seed should be allowed to become perfectly dry. The produce varies from 2½ to 6 bushels per acre, when cleaned. Cleaning the seed for market, requires a machine for the purpose worked by horse-power. In consequence, many farmers sow it mixed with the chaff, in which case they must judge as well as they can of the quantity.

Clover seed should be large, full, glossy, and of bright orange yellow and bold purple mixed; when handled it has an oily feel. Damaged seed is said to be frequently dried and polished in England for sale, but this can generally be detected by the rougher feel, and the duller appearance; and still better by sprouting it as directed for the grasses. The Statute weight in Michigan is 60 lbs. to the bushel, but the best seed will weigh as much as 64 lbs. or over. At 64 lbs. to the Imperial Bushel, 2000 grains weigh one drachm. (*Stephens.*) The seed of White Clover is very small, of a rich golden yellow color, weighing 65 lbs. to the bushel, and affording 4000 grains to a drachm weight. (*Stephens.*) New seeds are the best, the germinating power failing the second year. Large quantities of the seed of Red Clover are annually exported to Europe.

421. In making clover hay, great care must be taken that the leaf is not so scorched and dried up as to break into powder; which too often happens, to the great injury of the hay. This may be avoided by the following process. While mowing, have men to follow, and put every swathe into small cocks, at about a rod distance. On the second day, or if the weather is damp, not till the third, turn over one of those small cocks, and place two more upon it, laying the greenest part nicely on the top so as to shed rain; then let it remain several days. It becomes a little heated, and the moisture all evaporates through the cock. Before hauling in, open the cocks, and air them for an hour previous. By loading and unloading it receives air enough to be thoroughly cured, if sufficiently sweated in the cock.

It remains green, with all the leaves upon the hay, just as it came from the scythe. *(A. Y. Moore.)* The same may be accomplished more rapidly, though perhaps not quite as perfectly, by allowing the clover to lie in swathe just long enough to wilt, and be warmed through. Then put in small cocks, and leave two days, if the weather is dry and hot, longer if cloudy or damp; air before hauling, and salt as directed for grass-hay. We have followed this plan for many years with great success. The clover is not quite dry when put in the shed, but the salt prevents any injury. We prefer it to be damp enough to melt the salt, and partially heat.

422. In the United States clover appears to be free from any peculiar enemies or diseases. In Europe it suffers from several.

In some of the Eastern States, a caterpillar has been found in large numbers spinning its webs over the clover, but it does not appear to be very injurious, nor is the species accurately determined. *(Harris' Treatise,* 2nd ed. p. 354.*)*

But in both continents, the land sometimes fails to produce clover when sown, a condition known by the name of *Clover Sickness.* While Agricultural Chemistry was unstudied, this peculiarity was the cause of much wonder and many disputes. It is now well known to be owing to the deficiency of the soil in one or more of the inorganic constituents requisite for clover; and can be cured by special manures; by sowing it at longer intervals; or by using a different rotation of crops. To this cause may also be attributed the dying out of clover after having partially attained its growth, which sometimes occurs in over-cropped wheat lands. Seed still retaining its chaff, or outward covering, is supposed to be less subject to failure than when clean, which is probably true. Where Red Clover is apt to be destroyed in winter, by the frost raising the roots out of the ground, it may be partially or wholly prevented either by

leaving the aftergrowth uneaten, or by spreading straw heavily over the sod to be left all winter, and then raked off.

423. Besides the true Clovers or Trefoils, several other plants closely resembling them are more or less used, in Great Britain, to mix with grass seeds. Two of them are natives of the United States—*(a.)* Sweet Clover, or Yellow Melilot *(Melilotus officinalis,)* and (*b,*) White Melilot (*M. leaucantha,*) but the most important of this genus is (*c,*) the Bokhara Clover, (*M. leucantha major,*) a biennial. It stands the winters in Scotland, and probably would in our middle States. Two species of the Bird's-foot Trefoil are also used in England. (*Lotus corniculatus,* and *L. major.*) Besides these, the following might be profitably introduced among us. (*d,*) Burnet, (*Poterium Sanguisorba.*) This is frequently grown in gardens as an herb ; and we find it quite hardy in damp loam on the Detroit River, though it naturally belongs to dry and calcareous soils. It is one of the first plants to become green in spring. It enters largely into old English meadows and pastures, and from its peculiar bitter and aromatic flavor, would probably be beneficial for sheep in miasmatic climates. (For picture and description, see *Patent Office Report,* 1847.) (*e,*) Yarrow or Milfoil, (*Achillea Millefolium*)—a native of the United States. It is closely eaten by pasturing animals, and has long been cultivated in Great Britain along with other herbage plants. (*f,*) Ribwort, or Plantain. (*Plantago lanceolata.*) According to Prof. Gray, this is extensively naturalized in the Eastern States. Cattle greedily eat our common Plantain, (*P. Major,*) a well-known weed around houses.

424. Lucern *(Medicago sativa,)* together with the next mentioned, are extensively cultivated as fodder plants in some parts of Europe, but are of little practical interest, at present, in the United States. This is a perennial, grows a foot and a half to two feet high, and flowers in June and July. It requires a deep light soil, with an open subsoil. It is sown either broadcast, or in rows, and cultivated with the hoe and cultivator, which process must be continued for at least three years; till which period it does not arrive at its full growth. When sown broadcast, it has also to be kept clean with the hoe, like turnips. There are two species, both of which have become naturalized in the Eastern States.

425. SAINFOIN *(Onobrychis sativa,)*—(from the French *sain, healthy—foin hay)*—is, likewise, a perennial, but belongs almost exclusively to the chalk and lime formations and light sands. It is on dry rocky soils that the chief advantages of its cultivation are observed.

It may be cultivated like clover, or grown in rows like the last. It is used either as hay, for soiling, or pasture. It contains 76.64 per cent of water, and 4.32 flesh-forming principles, being slightly more nutritious than Red Clover. *(Way.)*

Boussingault (See *Rural Economy*, chap. vi., p. 321, New York ed.,) found this crop to vary, per acre:

Dry herb,	2068 lbs. to 5462 lbs.
Seed,	66 lbs. to 582 lbs.
Weight of total crop,	2134 lbs. to 6044 lbs.

Plaster has as remarkable an effect upon it as on clover.

426. Analyses of Lucern (*Sprengel*) (A,) and Sainfoin (*Way*) (B):

	A.	B.
Organic matter,	89.6	93.7
Ash,	10.3	6.36

Inorganic analyses of the above, *(Liebig and Way.)*

	A.	B.
Sand and Silica,	2.3	3.2
Potash,	17.3	31.9
Soda,	4.9	
Lime,	28.5	24.3
Magnesia,	6.7	5.0
Oxide of iron,	0.4	0.6
Chloride of sodium,	2.3	0.8
Phosphoric acid,	6.6	9.4
Sulphuric acid,	1.0	3.3
Carbonic acid,	29.0	15.2
Chloride of potassium,		6.2

427. CHICORY *(Cichorium Intybus,)* also called "Succory," is a native of England, but it has become naturalized in the Atlantic States. It is recommended as a fodder plant, and the root is extensively used in Europe to mix with, or as a substitute for, coffee. The rich aromatic bitter of the French coffee is chiefly owing to this. In Italy it is made into hay; in

France it is cultivated extensively for forage, and enters into the regular rotations of the fields. It is attracting much attention at present in England. It will withstand the severest cold, and bear drought well, its large leaves covering the ground, and the root striking deep into it. It comes very early in the spring, and may be cut for soiling several times in the year. It is a perennial with very ornamental blue blossoms.

428. Comparative analysis of the dry root (A,) and fresh root (B,) of Chiccory. (*Dr. Anderson.*)

	A.	B.
Water,	18.01	80.58
Ash, on dry,	3.64	6.77
Nitrogen, on dry,	1.60	1.48
Ash on moist substance,		1.31

429. Inorganic analysis. (*Ibid.*)

	I.	II.
Silica,	3.790	0.99
Peroxide of iron,	0.657	0.81
Lime,	8.644	6.09
Magnesia,	5.777	3.15
Sulphuric acid,	13.048	4.80
Phosphoric acid,	13.882	10.02
Potash,	29.687	42.60
Chloride of potassium,		1.78
Soda,	7.641	
Chloride of sodium,	2.555	6.83
Sand,	3.271	1.12
Charcoal,	2.567	9.90
Carbonic acid,	7.927	11.40

It seems from the above that the plant has great powers of appropriation or replacement of constituents. It probably is able to replace the potash with soda.

430. Where this plant is grown for the sake of the root the following is the English mode of cultivation. The autumn previous to sowing, the land must be manured and deeply plowed, and if it be dry and porous,—the best for this crop—harrowed before winter. About the second week in May, the soil is ridged up so as to deepen it, and facilitate subsequent

hoeing, and the seed sown at the rate of 3¼ to 4 lbs. per acre in drills, 12 to 14 inches apart. The plants will not appear for a month or six weeks, and during this period care must be taken to keep down the weeds with the cultivator. The plants, if too thick, should be thinned to 5 or 6 inches. The subsequent cultivation consists in careful hand-hoeing. Late in October the roots are dug with a three-pronged fork. The leaves may be previously removed and fed to sheep. When taken up the roots are topped and tailed, then washed, and cut into slices like turnips, only in lengths as equal as possible. They must be dried, either by exposure to the sun, or in kilns, when they are ready for market. The usual yield is from 12 to 15 tons of the wet roots per acre, the latter diminishing when dried to about 1½ tons. The price in England varies from $50 to $150 per ton. When used, the slices are roasted and ground like coffee. The principal objection to this crop is the great difficulty with which it is afterwards eradicated, the smallest fibre left in the ground forming a plant. Still this may be accomplished, or nearly so, by hoeing. Sheep, in common with all stock, are very fond of the leaves, and prosper well upon them; and a few acres devoted to this esculent would prove valuable for early and late sheep-feed, and for horses and cattle in summer. If sown broadcast 12 to 14 lbs. of seed to the acre are required.

431. White Mustard, *(Sinapis alba,)* has of late years been cultivated in England as a forage plant, but from experiments we have made with it, it does not appear to be suitable to this climate. The heat dwarfs it, and it is seriously injured by a minute black beetle, which attacks it early in spring. In light soils, however, it might succeed better.

These constitute all the forage plants that can be of interest in the Northern States; except Rape which will be described in the next chapter.

CHAPTER XV.

PLANTS CULTIVATED FOR THEIR ROOTS, AND LEAVES. TURNIPS. *(Brassica.)* KOHL RABI. CABBAGE. RAPE.

432. In Great Britain and Germany roots are grown to a very great extent to feed stock, and to act, indirectly, as a renovator of the soil, in rotations. It is not yet a century, since the present *system* of root culture was introduced, but it has entirely revolutionized Agriculture, and the Art could not now be profitably exercised without it. This class of plants is not numerous, and they owe their beneficial effect on the soil chiefly to the fact that they are not allowed to seed. If they bear seed, they cease to be "fallow crops," and in their effects become similar to the cereals. They may be comprised in the genera, *(a,)* Turnips, (including Cabbages;) *(b,)* Potatoes; *(c,)* Carrots; *(d,)* Parsneps; *(e,)* Beets; *(f,)* Jerusalem Artichokes; *(g,)* Onions; *(h,)* Sweet Potatoes. Still more are cultivated as garden plants. The climate of a great portion of the United States is but illy adapted for the winter-preservation of several of these roots; and this fact, together with our less scientific and more careless mode of farming, has tended to discourarge their cultivation. In the older States, however, more attention is now being paid to this subject, and there are none of the above which may not be successfully and profitably cultivated in Michigan. The profit of a root crop is two fold—direct and indirect:—*direct*, when we sell or so consume the produce in feeding animals as to realize more money than the production has cost us; *indirect*, when our only profit is in

the manure and the improvement of the soil for succeeding crops. English farmers are content to grow large fields of turnips, &c., and fatten many head of stock, merely for the benefit which the succeeding grain crops will receive.

433. Turnips belong to the botanical family of CABBAGE, *(Brassica,)* of which the following species are cultivated in the United States.

(a,)	*Brassica Rapa,*	Common Turnip.
(b,)	" *Napus,*	Rape, or Cole.
(c,)	" *Oleracea,*	Cabbage,

The true Turnips again are thus divided:

(a,)	*Brassica Rapa,*	Common Turnip.
(b,)	" *Campestris Napo-brassica,*	Swedish Turnip.
(c,)	" *Napus esculenta,*	Turnip-rooted Cole.
(d,)	" *Oleracea Caulo-rapa,*	Turnip-stemmed Cabbage or Kohl-rabi.

Of the turnips, there are very many sub-varieties originated by cultivation, such as round, depressed, fusiform, white, green, and red, each of which is supposed to possess some peculiar good qualities. We shall, probably, originate in the United States varieties better adapted to our climate than those of Europe. The three great divisions at present are, *(a,)* The Common Turnip; *(b,)* The Hybrid Turnip; and *(c,)* the Swede, (or *Ruta-Baga,* a name, but rarely used by English writers.)

434. The Common Turnip is too well known to need description. The Hybrid *(b,)* has the leaves of the Common Turnip, and the character of Rape and of the Swede, and is supposed to be formed by a cross of these three. It is hardy, nutritious, and less apt to be injured by frost. The Swede *(c,)* is hard, yellow, containing less moisture, and keeps longer into spring, so that it is the last consumed.

435. The soil best adapted to this crop contains a small amount of clayey matters, and is characterized by its light, loamy texture. Barley and Turnips usually prosper well on the same soil. The following are analyses made in Scotland, of two different specimens of good "Turnip soils," on which such crops had just been grown. *(Dr. Anderson.)*

Insoluble silicates,	87 89	90.695
Soluble silica,	0.07	0.073
Peroxide of iron,	2.94	1.233
Alumina,	1.59	0.893
Lime,	0.38	0.319
Magnesia,	0.13	0.279
Potash,	0.14	0.056
Chloride of sodium,	0.10	Soda 0.043
Sulphuric acid,	0.05	0.039
Phosphoric acid,	0.04	0.018
Organic matter,	4.66	4.996
Water,	1.75	1.444
Chlorine,		trace.
Nitrogen,		0.164

These analyses, are valuable not only in this peculiar aspect, but as a standard whereby to compare our own soils. They had long been cultivated and highly manured.

436. The meteorological conditions of the country seriously influence the yield of turnips. Thus Scotland and the West of England, with their greater amount and frequency of rain, produce larger crops than the Eastern shores of the same country, *(C. W. Johnson;)* while in most parts of the United States, we are obliged to sow late to escape the heat, and the roots are very much smaller.

437. Ultimate ANALYSIS of the Turnip. *(Boussingault.)* A slice weighing 2 oz. 17 dwts. dried in the stove was reduced to 4 dwts. After thorough desiccation, one part of turnip weighed 0.075, consequently the root contains 92.5 per cent of water. One part of dried turnip left 0.0758 of ash :

	I.	II.
Carbon,	42.80	49.93
Hydrogen,	5.54	5.61
Oxygen,	42.40	42.20
Nitrogen,	1.68	1.68
Ash,	7.58	7.58

438. Water (A;) solid matter (B) and ash (C;)—100 parts in moist state—in turnips, grown in four different localities in Scotland. *(Dr. Anderson.)*

			A.	B.	C.
White Globe Turnips		(*a*,)	93.18	6.82	0.67
do	do	(*b*,)	92.85	7.15	0.78
do	do	(*c*,)	94.03	5.97	0.69
Swedes,	do	(*d*,)	90.07	9.91	0.57

439. Inorganic analysis of the same turnips. *(Dr. Anderson.)*

	A.	B.	C.	D.
Silica,		0.60	0.18	0.28
Potash,	47.460	44.11	42.83	48.02
Soda,	2.655	5.48	13.66	3.93
Chloride of sodium,	13.990	21.99	5.45	7.04
Lime,	8.689	7.91	9.23	10.67
Magnesia,	4.555	3.88	4.97	4.45
Sulphuric acid,	12.603	9.03	12.23	12.16
Phosphoric acid,	8.613	6.81	11.14	13.07
Peroxide of iron,	1.435	0.19	0.31	0.38

The proportion of nitrogen in healthy turnips varies within extremely wide limits, and that without any assignable cause. In two of the above specimens the nitrogen was respectively 3.81 and 2.54. By comparing the analyses of other chemists the nitrogen may be averaged from 1.65 to 4.31, equivalent to 2.00 and 5.22 of Ammonia. From these facts we learn that this plant varies not only in its agricultural requirements but also greatly in its nutritive powers; and that one ton of turnips may be capable of forming as much flesh, as two and a half tons grown on a different soil. Dr. Anderson places the average of the flesh-forming matter in turnips as low as 1.27 in 100 parts of the fresh substance. The phosphates vary in a like manner. In 12 analyses of turnips of two varieties, grown on different soils, and with different manures, these varied from

6.8 on clay to 17.6 on "black land;" while the nitrogen in the fibre, and the nitrogen in the juice, equally uncertain, appear to bear no relative proportion to each other.

440. Organic analysis of Swedes. *(Johnston.)*

Albumen,	3.5
Fat and oil,	2.0
Gum, Dextrine and pectine,	14.9
Sugar,	58.9
Fibre and husk,	20.3

"The potato is characterised by containing a large proportion of starch in connection with a small quantity of albumen—the turnip and carrot by containing in place of the starch a variable proportion of sugar, and of a gelatinous gummy-like substance, to which the name of *pectin* has been given. In the Swedish Turnip and in the carrot the pectin is usually present in the larger quantity." *(Johnston.)* The same writer gives the following comparative table; remarking, however, that "these analyses are very defective, and apply with any degree of correctness only to the specimens actually operated on." They will answer, at the same time, to give a general view of these plants.

	Variety of Turnips.					
	White.	Swedes.	Cabbage.	Common carrot.	Sugar beet.	Parsnip.
Water,	79.0	80.0	78.0	80.0	85.0	79.4
Starch and fibre,	7.2	5.3	6.0	9.0	3.0	6.9
Gum (pectin,)	2.5	3.0	3.5	1.75	2 0	6.1
Sugar,	8.0	9.0	9.0	7.8	10.0	5.5
Albumen,	2.5	2.0	2 5	1.1	?	2.1
Salt,	0.5	0.5	0.5	—	?	?
Loss,	0.5	0.2	0.5	oil 0.35	—	?

441. Average of water (A.) and ash (B.) in turnips grown in England, *(Way and Ogsden.)*

	Water.			Ash.			Ash Dry.		
	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.
Bulb,	92.7	86.0	90.0	1.13	0.48	0 73	10.90	4 00	7.30
Top,	90.0	79.0	85.5	2.64	1.19	1.84	18.00	8.00	12 98

The nitrogen in the tops appears to average much higher than in the bulb.

442. A crop of 20 tons of bulbs or roots, and 4 tons of leaves of turnips, mangel wurtzel, and carrots will respectively withdraw from the soil of an acre as follows:—(*Way.*)

	Turnips.	M. Wurtzel.	Carrots.
Phosphoric acid,	45 lbs.	21 lbs.	39 lbs.
Sulphuric acid,	50 "	22 "	57 "
Lime,	90 "	21 "	197 "
Magnesia,	14 "	22 "	29 "
Potash,	140 "	133 "	134 "
Soda,	33 "	70 "	103 "
Chloride of sodium,	57 "	160 "	85 "
	429 "	449 "	664 "

443. *Pectin*, or Pectic acid ($C_{12} H_8 O_{10}$) (*Solly*) is a substance analogous to gum, which exists in many plants, and especially in fruit. It is a tasteless solid, which swells up, and gelatinizes with water. It possesses feeble acid powers, combining with bases to form *pectates*. Containing no nitrogen, it belongs to the heat or fat forming constituents of food—and in this respect appears to act as an equivalent, in food, to starch. Pectic acid has been found in every plant for which it has been sought for; but in some it usurps the chief place, as in turnips, carrots, beets, Jerusalem artichokes, onions, and in all kinds of fruits. It is also found in the stalks and leaves of herbaceous plants, in the wood and bark of all the trees examined, &c. *See Boussingault Rural Econ. p.* 129. *Pereira on Food and Diet.* Ch. ii. § 6.

444. The characteristics desirable in the turnip are hardiness against insects and disease; rapid growth; moderate size of bulb; and capability of keeping sound and fresh. Not only are very large bulbs apt to be hollow, or cellular, but late examinations have shown that they contain, proportionably, less nutritive matter than smaller ones: in some instances the difference was as high as 50 per cent. In England some varieties are found much more liable to disease than others; and some retain their flavor and solidity longer than others. In all these respects, the Swedes appear to stand preeminent.

445. In Great Britain, the average *good* crop varies from 15 to 40 tons of bulbs "topped, tailed, and well cleaned" per acre, according to soil, and meteorological locality; while the *tops* of Swedes reach as high as 17 tons on the same area.

" If planted 28 inches from row to row, and 10 inches from turnip to turnip, each turnip taking up 280 square inches, there would be 22,402 turnips, which at 3 lbs. each is 30 tons, 6 lbs. per acre; at 4 lbs. each turnip, 40 tons, 8 lbs. per acre."

In New York and Pennsylvania 600 bushels per acre of the common turnip are generally considered a good crop. The *Farmers' Cabinet*, iii. 17, mentions an instance where 850 bushels were raised to the acre. The Swedes yield one-third more than the common variety; of these 1200 to 1600 bushels have been raised to the acre. (*Wiggins.*) In Rensselaer Co., N. Y. a premium was given in 1848, for a crop of the last of 1,238½ bushels per acre.

446. The cost of cultivating the last named crop was as follows, the quantity of land being 1 2-10 acres.

Plowing the fall previous, - - -	$2.25
do and harrowing in spring, - - -	6.50
Light harrowing, previous to sowing, - -	50
Seed, - - - - -	75
Drilling in seed at $1 per day, - -	31
Thinning, weeding and after culture, 11 days, - -	8.25
Man and horse with cultivator 3 times, - -	2.50
14 days harvesting and securing, - - -	10.50
20 loads of manure, - - - -	13.00
Interest on land at $150 per acre, - - -	12.60
	$57.16
1,486 bushels at 12½ cents per bushel, - -	$185.75
Net proceeds, - - - -	$128.59

(*Trans. of N. Y. State Agricultural Society,* Vol. viii : p. 328.)

447. The culture of this crop in Great Britain is very complex, and has, perhaps, been more thoroughly studied than any

other. We must refer our readers to works especially upon the subject, merely laying down the following principles.

(a,) The soil for this crop should be light, rich, thoroughly plowed, and pulverized. Fair crops may be raised on some clay soils, but they require more labor to put them in a proper condition. No crop demands more thorough tillage previous to the sowing.

(b,) Drilling the seed, at 20 to 24 inches, the distance of the rows, instead of broadcasting, saves much after labor.

(c,) The land must be kept perfectly clean, and often stirred with the hoe.

(d,) The manures requisite are those which will supply nitrogen, and the peculiar inorganic constituents. Supposing the soil to be in a fair average condition, the following may be applied: 1. Super phosphate of lime; 2. Ground bones, in various states of preparation; 3. Guano; 4. Barnyard manure, or compost; 5. Common salt; 6. Wood ashes; 7. Lime; 8. Plaster. In rich English soils, guano, bones, and ashes, are usually considered sufficient.

(e,) It is exceedingly important that the young plant should be rapidly forced into the "rough leaf." Previous to this, it is subject to the attacks of several insects; and its future prosperity appears to depend on the early rapidity of growth.

448. In the United States, turnips are usually grown as a *second* crop in the fall, being sown in New York and Michigan from the end of July to the 12th of August. The Swedes require the longest period of growth. If sown broadcast, a quart of seed, if by drill, a pint is sufficient. The harvesting must be performed before hard frosts set in. The roots are pulled by hand, laid on the ground, the tops of the two rows facing each other. A man follows with a bill hook, and separates the tops from the roots. Three men will harvest 300 bushels a day. The tops are taken to the barn yard for the cattle. The best mode of storing is in root-cellars, with straw; but hills or pits—

such as are used for potatoes—may be made in the field. On feeding, the bulbs should be cut up. This may be done with a common shovel, but there are various machines for the purpose, which save much labor.

449. Fattening cattle, averaging 900 lbs. live weight, will eat 150 lbs. of common turnips daily, with 7 lbs. of oat straw.

450. In Europe, many diseases, such as *Fingers and toes, Black cracks*, &c. seriously injure this crop. In the United States it appears to be free from any general malady.

451. There are several insects which are more or less injurious in this country. The worst is the Black Flea-beetle (*Haltica pubescens.* Ill ?) if we do not have the *true* Turnip fly of Europe (*H. nemorum*); but little is yet known of this family. On a small scale, it may be driven off by scattering over the plants finely powdered plaster, or *boiled* plaster mixed with spirits of turpentine, and dried; but the best preventative is rapidly forcing the plant into the rough leaf. This insect is peculiarly fond of *White Mustard*, which may be sown in the neighborhood. In Massachusetts, the caterpillar of a white butterfly (*Pontia oleracea*) devours turnip leaves. The Iulus also bores into the roots, and even the common Earth-worm appears, in some way, to penetrate them.

452. If seed is required, the best roots should be selected in spring, set out about 2 feet apart, in good land, and hoed while growing. If any particular variety is required it must be kept far apart from any other.

453. The seeds of turnips contain much oil. The following production of seed and oil is given by Boussingault.

	Swedish Turnip.	Rape.	Kohl Rabi.
Seed produc'd per acre,	15cwt. 1qr. 25lbs.	16cwt. 2qrs. 18lbs.	13cwt. 3qrs. 19lbs.
Whole qnt'ty oil pr acre,	595.8 lbs.	641.6 lbs.	565.4 lbs.
Oil obtained per cent.	33	33	33
Cake pr. cent.	62	62	61

454. Kohl Rabi, *Turnip stemmed Cabbage*, is chiefly cultivated in Germany, where it is eaten both by man and animals. It is perfectly hardy on the Detroit river, is subject to few casualities, and is little affected by frost. It may be grown in the

seed-bed and then transplanted, like a cabbage, or drilled, and thinned out, and cultivated as turnips are. It should be sown as early in spring as the temperature will permit. It is much harder than any of the turnips, and in rich lands, apt to become stringy. We consider it worthy of more extended cultivation. There are two varieties,—the *green* and *purple*. *Horsford* gives the nitrogen as 2.17 per cent.

455. CABBAGE *(Brassica oleracea.)* Of this there is a great number of varieties, most of them adapted to garden cultivation. In some parts of Great Britain, the larger varieties are cultivated in fields for the purpose of feeding cows and other stock; but in the United States, the price of labor, and the climate will probably long preclude cabbages from being a field crop. They require very rich clayey soils, as well as high cultivation. The leaves average 92 per cent. and the stalks 84 per cent. of water. The nitrogen is believed to be proportionably greater than in any other plant consumed by man except perhaps mushrooms. The flower of one species (cauliflower) in the dry state has been found to contain as much as 64 per cent. of the flesh-forming constituents *(Johnston.)* The inorganic constituents resemble those required by the rest of the family, viz: the alkalies, sulphuric, and phosphoric acids, and chlorine.

456. RAPE. Two species of this are usually cultivated, Rape or Cole *(Brassica Napus)* and Colza *(B. campestris.)* The use is twofold—*(a)* as a forage plant; *(b)* to afford oil from the seed, the *cake* of which is largely consumed as a manure and as top dressing for wheat and other cereals. Rape is a native of England; is a hardy plant; and has a wider range of soils than the turnip. It requires also, less culture and manure; and can be produced under circumstances in which the turnip cannot be profitably cultivated. The root is of no value. As a pasture plant it is admirably adapted for sheep. Where the climate will permit, it may be sown in spring, for fall feed. It is usually drilled 24 inches apart, in the rows, and kept clean by

a cultivator, but, if the land is free from weeds, large crops may be raised by broad-casting. If drilled, 2 lbs. of seed to the acre will suffice. It weighs about 53 lbs. to the imperial bushel. The *cake* in London, sells for about $25 a ton, being one half the value of *Linseed cake*. In 1846, the Patent Office distributed the seed, and recommended its culture as an oil plant; but we are not aware that it has yet been generally introduced. As sheep-feed, in our large prairie country, south of Michigan, it is deserving of much attention, to take the place of grass in the fall. *(See Patent Office Report*, 1846, *pp*. 314, 400.*)*

In the same work for 1850, p. 190, J. E. Dodge, of Erie, Penn., thus writes :—" I have cultivated Rape for several years, and find it very profitable. The soil for growing Rape on should be rich and clean. A thorough old-fashioned summer fallow is probably the best for the Rape crop. It should be sown the last of August,—3 pints of seed to the acre. It will be ready to cut in the last of June or first of July. We cut it with large reaping hooks, and lay it in small bunches to dry, for eight or ten days. Then, with a large cloth spread over the hay-ladder, we proceed to haul in, and thrash with a flail immediately. The greater portion of the chaff is to be raked off, and the remainder left, with the seed, one or two weeks on the barn-floor to dry. It will produce from 30 to 50 bushels per acre. It is worth $1.00 per bushel in Erie."

It is understood, however, that the crop is occasionally injured by frosts, if uncovered by snow, in this latitude. As a green manure, to be eaten by sheep, and the roots plowed under, it is considered essentially valuable, and may profitably take the place of an occasional clover crop in wheat culture.

457. We have been unable to meet with trustworthy analyses of this plant; but in its general character it resembles the rest of its family.

458. Inorganic analysis of Rape *(Rammelsburg)* 100 parts of seed gave of ash 4.54,—of straw, 5.21.

	Seed.	Straw.
Potash,	25.18	8.13
Soda,	——	19.82
Lime,	12.91	20.05

Magnesia,	11.39	2.56
Peroxide of Iron,	0.62	
Phosphoric acid,	45.95	4.76
Sulphuric acid,	0.53	7.60
Carbonic acid,	2.20	16.31
Muriatic acid,	0.11	19.93
Silicic acid,	1.11	0.89

Dr Madden gives the constituents of the cake as—

Water,	10.5
Organic matter,	85.5
Earthy phosphates,	3.0
Siliciate of potash,	1

Frequently as much as 9 per cent. of soil remains in the cake, which affords nearly double the fattening matter of Indian corn, if it should prove equally available in digestion. Cattle are said to dislike the flavor of Rape cake, so that it is rarely used for feeding.

It may be stated in this connection, that Boussingault and Dumas consider that the oil of seeds is intended for the production of heat by undergoing combustion at the period of germination. Generally, oily seeds retain their germinative powers for a long period, but this does not appear to be the case with the cabbage family. Such seeds should always be fresh ; and certainly not more than two years old.

Mr. Low concludes his essay on this family in the following words, which are worthy of the serious consideration of American farmers :—" The extended culture of the turnip has enabled us to carry the practice of breeding and feeding our domestic animals to a state of perfection, in which no other country has yet been able to rival Great Britain. The cultivation of the plant in rows, instead of the former method of broadcast, may well be regarded as an improvement of the highest importance. It has enabled the farmer to secure abundant returns, which the former methods of cultivation did not admit of, and so to increase the number of useful animals that may be maintained upon the farm, and to subject the lighter soils to a species of culture more beneficial than any other that had been before devised for them."

To this it may be added, that while, in the northern United States, turnip culture may never be as profitable as in Europe, yet it may be very greatly increased, and by the production of new and hardy varieties adapted to our climate, and by improved processes of culture it may

be rendered as beneficial to the soil here as elsewhere. Not only will the improvement of our stock depend on the introduction of green or root-feeding during winter, but also the retaining the good qualities of the animals we import, must necessarily do so. They have been rendered what they are are by such feeding, and without it they must inevitably deteriorate.

In §444, it is stated that large bulbs "contain less nutritive matter than small ones." This subject has just been examined with great care and accuracy by Messrs. Sullivan and Gages, *Chemists to the Museum of Irish Industry*; and as some very important practical facts are now for the first time brought to light, we add them here: "On the continent where beet-roots are grown for the purpose of manufacturing sugar, it was long since remarked, that large sized roots yielded less sugar than moderate sized ones, between one and three pounds in weight. With a few exceptions it is now found, that as a general rule, small roots contain a larger per-centage of solid matter than larger roots. Thus 100 tons of the small roots of sugar beet would be equal to 167.43 tons of the large; 100 tons of small Mangel-wurzels contain as much solid matter as 142.18 tons of large; 100 tons of small Swedish turnips would be equal to 118.37 tons of the large, *in specimens of all these roots actually examined.*

The following table contains a summary of the mean results of the examinations of 450 roots.

Size of Roots.	White Selisian or Sugar Beet.	Long Red Mangel-wurzel.	Orange Globe Mangel.	Red Globe Mangel.	Swede Turnips	Red Carrots.	White Belgian Carrots.
Average of roots above 7 lbs. -	10.204	10.617	10.785	8.704	10 755		
" " " 5 lbs. -	11.653	11.476	11.028	10.115	11.257		
From 3 to 5 lbs. - - -	15.708	14 934	13.974	12.059	12.810		
Average of all roots, - - -	14.532	13.635	12.645	11.188	12.031	13.370	12.990

This table shows some unexpected results. Thus the sugar-beet contains the largest amount of solid matter of any of the root crops now cultivated; and red and white carrots, though usually sold at a much higher price per ton, are very little superior to ordinary Swedes, and much inferior to the varieties of beet. Of course, it is not pretended that the value of roots can be determined by the per-centage of solid matter alone, as its composition must be taken into account. But in the same variety of plant, it will give an approximation to the truth—indeed practically speaking a very close one; in different species, or dif-

ferent families of plants, it is absolutely necessary to take the composition as well as the quantity of solid matter into consideration. In the case of carrots, however, an examination of the solid matter does not show that they are superior to that of the beet. As a general rule we have found that those roots of a particular variety of the beet which had white flesh were superior to those exhibiting a colored flesh. Another cause of exception was that the roots which grew out of the soil, and whose upper segment was colored more or less green, contained less solid matter than those which had fully grown *under* the soil; hence if a large part of the root grows out of the soil, the portion thus exposed will partake of the character of the segment immediately below the crown. This would seem to recommend a change in the usual practice of culture."

CHAPTER XVI.

POTATO (*Solanum tuberosum.*) JERUSALEM ATICHOKE (*Helianthus tuberosus.*)

458*. Potato. This well known, and till lately, most useful esculent, belongs to the botanical family of *Solaneæ*, or the Night-shade Tribe, of which many of the species are poisonous. The potato itself, in an uncooked state, is, to a certain extent, injurious to human beings; and if kept till spring, in a dark place, a new chemical alkaline principle called *Solanine* is formed in the shoots, which is a powerful poison. *(For analysis, see Liebig's Animal Chemistry, note* 38.*)*

459. As the potato has much diminished in value as a field crop, and there is no prospect at present of the *Rot* being remedied, we shall say but little about it, considering it rather as interesting to the gardener than the farmer.

460. It is a native of South America, and is still found wild in Chili.

In 1545, a Slave merchant, John Hawkins, introduced the potato from New Grenada into Ireland. From Ireland the plant passed to Belgium in 1590. It was neglected in England till introduced by Sir Walter Raleigh in the beginning of the 17th century; and was not in general cultivation in Scotland till near the end of the eighteenth century. When the potato came from Virginia into England, for the second time, it was already disseminated over Spain and Italy. It has been ascertained that this root has been cultivated on the great scale in Lancashire, England, since 1684; in Saxony, since 1717; in Prussia in 1738. In 1710, it began to spread in Germany, but the famines of 1771 and 1772 seemed necessary to lead the Germans to cultivate it upon the great scale. In less than two centuries it has literally overspread the earth;

and at the present day is found growing from the Cape of Good Hope to Iceland and Lapland. (*Boussingault and Sir J. Sinclair.*)

The Egg Plant (*Solanum Melongena ;*) the Tomato (*Lycopersicum esculentum,*) and the Red Pepper (*Capsicum annuum,*) as esculents ; and Deadly Night-shade, (*Atropa Belladonna,*) a well known medicine, belong to the same family. The Bittersweet of our own woods and fences (*S. Dulcamara,*) may be mentioned as the Type in the Northern United States.

461. The plant may be propagated by *seed*, in which case a vast number of new varieties is originated; or by the *tubers*, which contain buds or germs from each of which a stem will arise; and the variety continue constant. The germ will grow equally well if severed from the tuber, retaining merely a small fragment of the skin and substance; and it submits to desiccation by a hot stove without losing vitality.

It has long been a disputed point whether it were better to plant the entire tuber, or to cut it up into fragments, but no accurate decision seems to have been arrived at. In consequence, we may conclude that the practical difference is very small. General custom leans towards the latter plan. "It has been observed that "eyes" or germs taken from tuber that have not been fully ripened are more vigorous than those that have been taken from such as have been very fully ripened. This leads to a rule in practice, that the tuber to be planted shall be those which were taken up before the stems had begun to decay in autumn." (*Low.*)

The number of varieties is very great, and always increasing. The chief distinction is that of early and late kinds.

462. The peculiar characteristic of this root is the quantity of starch that it contains in combination with much water, and potash in its ash. The quantity of dry solid matter depends much upon the state of ripeness to which it has attained. The ripest leave 30 to 32 per cent of dry matter, the least ripe only 24 per cent. The quantity of starch varies according to variety from 10¾ to 32 per cent; and, accordicg to Liebig, in the *wild* state, this root is almost destitute of nourishing constituents. Since the *rot* has prevailed, potatoes appear to have lost much of the starch they previously possessed. The crop, also, other-

things being equal, varies in the weight per acre, according to variety, more than perhaps any other cultivated plant. The quantity of starch is at its maximum in the winter. In the spring, vegetation becomes active, and the buds begin to grow at the expense of the starch contained in the tuber. Hence, at this season, potatoes are less mealy, and, in consequence, less esteemed for eating. The tissue of the potato consists of a mass of cells, and in these the starch is stored up in the form of grains, of the ordinary shape, and these congregate principally in a zone near the skin, and are less abundant toward the center; the remaining space, in and between the cells, is occupied by a thin albuminous liquor, constituting three-fourths of the total weight of the tubers. All the nitrogenous matter is dissolved in the juice, and consists almost entirely of albumen, with a very small quantity of *asparagin* and free acids. The substance of which the cells consist is essentially different from that found in other plants. It possesses the property of swelling in water into a translucent jelly, and of being transformed into sugar and gum by the action of acids, and consequently occupies a position intermediate between starch and woody fibre. Potatoes are readily frozen at a few degrees below freezing point, and when again thawed are soft and sodden, and allow the greater part of the juice to flow out—in fact, the cells are burst by the ice formed within them, the organic structure is destroyed and vitality lost; while decay speedily succeeds. A chemical change, when the freezing has been gradual, is often perceptible; the tubers become remarkably sweet, and contain an appreciable quantity of uncrystallizable sugar.

463. Ultimate ANALYSIS of the Potato:—*(Boussingault.)*

Carbon, - -	44.0	Water, - -	75.9
Hydrogen, - -	5.8	Solid matter dried at 230°	
Oxygen, - -	44.7	*Var. in vacuo*, -	24.1
Nitrogen, - -	1.5		
Ashes, - -	4.0		100.0

From this we see that the proportion of Nitrogen is very small; but it is still smaller in potatoes that have been kept for some time.

100 parts of - - - - -	Moisture.	Nitrogen in dried substance.	Nitrogen in undried substance.
Potato, fresh, - - -	79.4	1.80	0.37
Potato, kept ten months, - -	76.8	1.18	0.28

464. Proximate analysis of the Potato:

MICHAELIS.		JOHNSTON.		
Red Potato.			Natural state.	Dry.
Water, - -	66.875	Water, - -	75.52	
Starch and amylaceous fibre,	30.460	Starch, -	15.72	64.20
Albumen, - -	0.503	Dextrine, -	0.55	2.25
Gluten, - - - -	0.055	Sugar, - -	3.30	13.47
Fat, - - - -	0.056	Albumen, casein } Gluten, - }	1.41	5.77
Gum, - - - -	0.020			
Asparagin, - -	0.063	Fat, - -	0.24	1.00
Extractive, - - -	9.921	Fibre, -	3.26	13.31
Chloride of potassium, -	0.176			
Silicate, alumina, and salts, -	0.815			
Free citric acid, (?) - -	0.047			

According to Illisch, what was formerly believed to be *citric acid* is phosphoric, muriatic, and malic acids.

465. Inorganic analysis of the Potato. *(Boussingault; Fromberg; and Daubeny.)*

	Ash in 100 parts	Ash in artificially dried plant.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid	Sulphuric acid.	Silica.	Peroxide of iron	Chlo. of sodium	Carbonic acid.
Potato tubers,		4.0	59.96		6.28	2.09	13.16	8.27	6.52	0.59	5.20	Deduct
do		4.01	57.58	3.66	4.53	0.81	9.98	14.63	3.68	0.42	8.6	
do		3.75	49.73	1.93	5.03	3.31	14.58	18.04	2.49	0.56	7.5	
do	1.27		46.60		8.70	4.54	13.30	4.66	1.95	3.30	3.43	13.30
do	1.08		50.00	0.84	6.85	2.70	16.20	2.37	7.15	5.15	1.95	11.90
do	0.76		43.80		12.65	3.10	11.15	6.0	6.67	6.85	2.30	6.70
Mean of six analyses, Carb. acid deducted,		3.92	55.75	1.86	5.28	2.07	12.57	13.64	4.23	0.52	7.01	

466. According to Boussingault and Liebig, the nutritive power of the potato is very low. "A horse may be kept alive" says the latter "by feeding it with potatoes, but life thus supported is gradual starvation; the animal increases neither in size or strength, and sinks under every exertion." The true value of this tuber, as food, is evidently to supply carbon, in the shape

of starch, for the purpose of sustaining breath and heat, not for building up the body. Pereira estimates that 1 lb. of butcher's meat is equal to 10½ lbs. of potatoes. In consequence, those who live solely upon them are obliged to consume inordinate quantities; and the stomach, habitually distended with the great bulk, becomes unnaturally enlarged, and incapable of digesting concentrated food. This was shown during the Irish famine, when more than an equivalent of corn meal, or other nitrogenous food, being much smaller in quantity, entirely failed to suspend that craving which the stomach feels when empty.

At the same time, in consequence of the great yield per acre, much more nourishment can be produced from a given area of soil by this crop, than by any other except perhaps corn. The following example will prove this (*Knapp*):—

From one hectare of land (= 2.471 acres) there were produced under similar circumstances,

3,400 lbs. wheat,	2,800 lbs. rye,	2,200 lbs. peas,	38,000 lbs. potatoes,	or
3,036 do	2,538 do	2,980 do	9,500 do	

after deducting the amount of moisture. In this quantity of dry produce there is contained:

	In wheat.	In rye.	In peas.	In potatoes.
Nitrogenous matters,	570 lbs.	440 lbs.	560 lbs.	950 lbs.
Starch,	1,590 "	1,196 "	780 "	6,840 "
Mineral ingredients,	90 "	62 "	60 "	323 "

And in consequence, when the Irish learnt to depend on this food alone, cultivating chiefly with the spade, population very rapidly increased; the land was subdivided into portions too small to be profitably applied to grain—for where one acre of potatoes would sustain a family, it would require many acres of grain to do the same, together with the necessary cattle—and when this crop failed, there was nothing to fall back upon, starvation ensuing in consequence. In India, the same results follow the dependence on rice, in many respects a very similar food. It may be laid down as a general principle, that the more highly civilized, intelligent, and prosperous nations are, the greater amount of nitrogenous vegetable and animal aliment do they consume; and in wearing out the soil of a single farm, or of a State, the decline is gradually from muscle-forming to heat-producing pro-

ducts, and finally to grass, for cattle raising, for the use of distant communities. But as the grass-product becomes general the population gradually decreases in numbers.

467. We shall not attempt to explain the cause of the Rot, nor yet repeat the various theories which have been originated. The ablest scientific men—while each has his own private opinion—acknowledge their inability, satisfactorily to account for it, any further than for the cholera and similar human epidemics. It is probably owing to some undetected atmospheric influence, and *may* be connected with electrical phenomena. One fact, however, appears to be generally acknowledged, viz, that rich, ammoniacal fermenting manures, tend to increase the disease, and that new soils, of a porous character, or old soils supplied with inorganic manures, are apt to produce the healthiest tubers. It is a peculiarity in this case, that remedies which are successful in one instance or locality, entirely fail in others; and thus, all specific curative means are now looked upon with suspicion. In Russia, drying the potato soon after digging, by artificial heat, has been found successful, yet failed in England; while, in Michigan, Mr. Mott and others have remedied the evil by leaving the tubers intended for seed in the ground where they grew until required for planting, taking the precaution to plant deep and cover with straw to prevent freezing. It is certain that in some soils this is a perfect preventive, and some unexplained change goes on in the potato; for, in the second season, the old potato which has acted as seed will be found perfectly sound, but altered in flavor. The same gentleman recommends leaving the tubers, intended for eating in the spring, in the ground all winter, when they will be found as fresh and unaltered as they were in the preceding autumn. *(See Farmer's Companion and Horticultural Gazette, Vol.* i, p. 77. ii, p. 14.*)* The following receipt has been lately published by an English farmer, not only as a manure, for which purpose it is undoubtedly excellent, but also as a preventive:—*(Agricultural Gazette.)*

30 lbs. wood ashes,	20 lbs. common salt,
15 lbs. burnt bones, in fine powder,	30 lbs. air-slacked lime,
10 lbs. plaster, (*sulphate of lime*,)	7 lbs. nitrate of soda, (*saltpetre*)

The whole to be intimately mixed. When planting, put into every hole an ounce of the above, cover it with some earth, and plant the tuber, or cutting above it. Habitually damp, undrained, adhesive clays should be avoided for this crop, while sands, gravels, and loams, lying on a porous subsoil, may often be successfully tried, even now.

468. In Great Britain, the potato was considered as a *fallow-crop*, and improved the land still more in consequence of being liberally supplied with fresh animal manures; and the surface, between the plants, being frequently plowed and hoed. Great pains were taken in preparing the field, and it was left in fine condition for wheat or other grains, which will not bear the direct application of dung. In our rotations, corn may take this tuber's place, especially if planted at distant intervals. In that country it was and is usually grown in rows, the earth being heaped up around the potato plant as it grew. In the United States much less pains have generally been taken, and the *hill* system is commonly followed; 4 potatoes, or *sets*, being planted close together in each hill. These hills are from three to four feet apart, and the interval is worked and kept clean with the plow and hoe. Undoubtedly the largest crops per acre can be raised on the English plan. When healthy, the time for digging, is when the stalks and leaves have partially withered; or when the skin of a tuber, recently unearthed, cannot be readily rubbed off with the hand. In Michigan, there is usually a period in October of *the* two or three weeks, when the weather is steadily fine, dry, and warm; but is succeeded by rains and frosts. This time, then, should be seized for the harvesting of this crop. The Irish dig with a spade or shovel; the New Englanders with a fork; or potato-hoe. The first, our experience teaches us to be the most rapid, and cleanest; but the shovel,

when lifted, requires a peculiar twist of the wrist, by which the earth and tubers are separated, and deposited in different places, which *twist* requires practice to accomplish successfully. In harvesting, it is important that the potatoes be not left exposed to the air and sun longer than can possibly be avoided. When first dug they are peculiarly sensitive to light, and if kept covered in the wagon with a thick cloth, or straw, till laid by in a dark place, they will retain their *mealy* qualities much longer than otherwise. A potato, exposed partially to the air in growing, turns green, moist, and unpleasantly waxy. This mistake is often made; the tubers being left on the ground in small heaps, for at least a whole day, or even several days. While this was an important crop with us, we always threw them into a corn-basket; and this, as soon as it was full, was emptied into a covered wagon; the consequence was, that the potatoes were remarkable for their fine flavor, and good qualities.

469. Besides being used in the ordinary shape, many preparations of starch were prepared from the potato. The larger quantity of the starch used by the laundress, and articles sold under the name of *Arrowroot Farina*, &c., were derived from this plant. *British gum*, (Dextrine,) extensively used in stiffening calicos, and applied to the back of postage stamps, is formed from *wheat* starch by roasting, or by nitric or sulphuric acid, *potato* starch failing to produce it. The water, in which potatoes have been boiled, is destructive to lice upon hogs, cattle, &c. The potato possesses a peculiar curative power over the Scurvy which attacks sailors confined to salt meat. In France, an extensive manufacture of Sugar from Potato Fecula or Starch is carried on. "Thus by the aid of Chemistry we obtain sugar from potato-starch, sulphuric acid, chalk, and water. The sugar is used for giving "body" to Burgundy wine, and for confectionary." *(Annual of Scien. Disc. Vol.* 1, *p.* 173.*)*

470. JERUSALEM ARTICHOKE (derived from the Italian word for Sunflower, *girasole ;* i. e. *girare*, to turn, and *sole* sun,—bearing no reference to the *City of Jerusalem*,) belongs to the family of Sunflowers, and is a native of America. It was introduced into Europe probably from Mexico in 1497; and was much esteemed before potatoes were generally used; and in case

of the total loss of the latter esculent, may be so again. In France and Germany it is extensively grown as food for stock; we remember seeing, a few years since, large fields of it near Massilon in Ohio, and it has been successfully tried in New York, Alabama, &c. In the United States, however, it is not usually cultivated, except in gardens. Both the tubers and stalks are valuable. The first are occasionally eaten, either boiled or roasted, by men, but are not in the present day much esteemed as a vegetable, being apt to produce flatulency. The tubers grow in clusters attached to the true root, somewhat in the manner of potatoes, and the stems are from 5 to 10 feet in height, with a considerable quantity of large leaves. In Michigan it flowers, but does not bear seed. The crop is large, giving from 10 tons, to 1,200 bushels of tubers, and 11½ cwts. of *dried* stems per acre. *(Boussingault, and N. Y. Cultivator.)* The tubers, when once planted, are very apt to spread, and are difficult to eradicate; but in Europe this inconvenience appears to be obviated by turning swine into the field. "Taking into account the hardy qualities of this plant, its productiveness, and easy culture, it may be doubted whether it merits the neglect into which it has fallen. Granting its inferiority as an article of food for cattle to turnips, &c, it must be of some importance, especially since the potato has failed, to have a plant that can be so easily raised, and on soils so low in the scale of fertility." *(Low.)*

471. Ultimate ANALYSIS of the Tuber (A) and dried Stem (B) of the Jerusalem Artichoke. *(Boussingault.)*

A tuber fresh from the ground weighed 1 oz. 15 6-10 dwts: after drying in the stove 7-10ths dwts: after complete desiccation, one part was reduced to 0.208.

	A		B
	I.	II.	
Carbon,	43.02	43.62	45.66
Hydrogen,	5.91	5.80	5.43
Oxygen,	43.56	43.07	45.72
Nitrogen,	1.57	1.57	0.43
Ash	5.94	5.94	2.76

In this analysis of the stalks, the carbon and nitrogen are probably rated too low. It will be observed that these tubers are almost identical in composition with the potato, the only essential difference being a little more ash in the first. According to the same writer, 30.8 lbs. of Jerusalem Artichokes are equal to 11 lbs. hay, as food for horses. "These roots are excellent food for the horse; they are eaten greedily, and he thrives upon them."

472. Proximate analysis of the tubers of the Jerusalem Artichoke. *(Braconnot.)*

Uncrystallizable Sugar,	14.80
Inuline,	3.00
Gum,	1.22
Albumen,	1.00
Fatty Matter,	0.09
Citrates of patash and lime,	1.15
Phosphates of potash and lime,	0.20
Sulphate of potash,	0 12
Chloride of potassium,	0.08
Malates and tartrates of potash and lime,	0.05
Woody fibre,	1.22
Silica,	0.03
Water,	77.05

M. Payen found a larger proportion of Sugar in this tuber than that stated above, and he ascertained that the fatty matter consists of stearine and elaine.

Boussingault found :—

Of dry matter, 20.8 | Water, 79.2.

473. Inorganic analysis of the tuber of the Jerusalem Artichoke. *(Boussingault.)* Per centage of ash in dry state 6.00.

Potash,	54.67
Soda,	traces
Lime,	2.82
Magnesia,	2.21
Oxide of iron, alumina, &c.,	6.39
Phosphoric acid,	13.27
Sulphuric acid,	2.70
Chlorine,	1.97
Silica,	15.97

It will be observed how rich in phosphoric acid this plant is,

and consequently how beneficial for growing animals; but in order to derive all the benefit possible from this fact, either water rich in lime, or some food containing an abundance of calcium should be supplied at the same time.

Inuline (C_{24}, H_{21}, O_{21}.) is a variety of starch found in the dahlia, and many other plants; specific gravity, 1.356, fuses at 212°; rendered yellow by iodine. Its aqueous solution does not gelatinize in cooling. (*Solly.*)

The following is the result of the analyses of two varieties of Jerusalem Artichoke—the white and red—made by Dr. Salisbury of Albany, N. Y., in 1850:—

	White Tubers,	Red Tubers,	Tops of red variety.
Water, - -	83.608	68.35	40.08
Dry matter, -	16.392	31.65	59.92
Ash, - -	0.774	1.352	3.85
Ash Calc. or dry matter,	4 728	4.27	6.425

Inorganic analyses of the tubers of White [A,] and Red [B,] Jerusalem Artichokes, and the tops of the Red variety, [C,] grown near Albany, N. Y.:—

	A	B	C
Carbonic acid, - - -	21.75	23.10	trace
Silicic acid, - - - -	1.60	1.40	26.55
Phosphoric acid, - - -	9.75	12.05	11.10
Phosphate of iron, - - -	1.20	1.25	3.25
Lime, - - - -	1.95	3.35	18.30
Magnesia, - - - -	0.55	0.30	8.85
Potash, - - - -	42.20	43.65	11.40
Soda, - - - -	15.25	6.60	15.85
Chlorine, - - -	2.55	2.65	0.85
Sulphuric acid, - - -	1.95	4.45	4.05
	98.75	98.80	99.60

Proximate analysis of the fresh tubers of the White [A,] and Red [B,] Jerusalem Artichoke; and of the fresh tubers of the Potato, [C.]

	A	B	C
Water, - - -	83.608	68.330	74.712
Fibre, - - -	2.232	3.676	6.829
Sugar and extract, - -	3.952	7.688	2.367
Dextrine, - - -	2.652	5.436	0.923
Casein, - - -	2.052	4.400	2.054

	A	B	C
Albumen, - - -	2.080	4.086	0.185
Starch, - - -	2.850	5.884	12.399
Resin, - - -	0.168	0.184	trace.
Glutinous matter, - -	0.096	0.122	0.009
Fat, - - - -	0.024	0.018	0.008

Ultimate organic analysis of the dry tubers of the White [A.] and Red [B,] Jerusalem Artichokes:—

	A	B
Carbon, - - -	45.817	45.918
Oxygen, - - - - -	40.926	40.566
Hydrogen, - - -	5 768	4.829
Nitrogen, - - -	3.378	3.597
Ash, - - -	4.728	4.270

474. The tubers are an excellent food for milch cows, horses, and sheep, but should be used in connection with dry food and salt. Hogs likewise prosper upon them; and when the ground is not frozen, they can help themselves and save the cost of harvesting. The nourishing quality of the root is very little, if any lower than that of the potato, while its inorganic constituents are more useful. The stalks are nearly as valuable as the tubers; and in this respect it has an advantage over the potato. Although cutting the stalk in the beginning of September may diminish the growth of the tubers—which is questionable—the fodder that is obtained at that season will fully compensate for the loss.

According to Schwertz, 100 kilogrammes (=220.548 lbs. avoirdupois) of *green* stalks, equal as regards nutritious qualities 31.250 kilogrammes of hay; but the value is increased if they are mixed with other vegetable matters. If for winter fodder, the stalks should be left as late as possible, cut, and dried as hay; and in this condition all domeetic animals eat them. In some parts of Europe, the stalks are also used as fuel; and Boussingault found them profitable as absorbers of liquid manure,—owing to the amount of pith—when thrown into hog-pens.

475. The soil and climate appear to matter little. The tu-

bers, either above or below ground, bear a degree of cold that no other cultivated root will do. They are thus of essential utility in northern climates, and may be left in the ground all winter, if wanted for early spring use. This plant can bear the effects of great heat equally well. With the exception of marshes, all places and all soils suit; and even the shade of trees, in moderation, is not injurious. The following results have been arrived at by experiments in France:—

Alluvial land gave,	20.868	Kilog. of	tubers.
Turfy land, *very dry,*	26.768	"	"
Sandy clay,	22.563	"	"
Calcareous earth,	18.908	"	"

From which it would appear that dry and light soils agree best with this plant.

476. In Europe, where Artichokes enter regularly into rotations, the ground is prepared and manured as if for potatoes, in the spring: and planting should be accomplished, as early as possible. They may, however, be planted, equally well, late in the fall, in dry soils. Whole tubers are used, and placed in rows, at about 1 inch below the surface, leaving sufficient space between the rows to use the cultivator, and the plants about nine inches apart. When they appear above ground, the soil is kept clean with the plow or cultivator, and hand hoe. If not harvested the first year, they will cover the whole surface of the ground the second season.

477. The stalks, if intended for dry fodder, must be left as late as the climate will allow of their being entirely dried. They may be cut with a strong sickle, or a corn-knife, from 2 to 3 feet above the ground, if tall; or in proportion, if short. They are lightly bound in bundles, and seven of these bundles are placed in shocks. After a week, and when the outside leaves are well dried, the shocks are separated, and replaced, so that 14 stand together, and 7 are placed on the top, like a roof, with the cut ends upward, and strongly fastened toward that end. In this way they stand till perfectly dry.

478. The tubers may be dug when convenient, in the same manner that potatoes are; but, if another crop is intended to succeed, great care must be taken to gather up every portion. As they grow in clumps, a little experience will render this easy. If it is intended to continue artichokes on the same ground enough small tubers may be left to serve for seed next season.

479. If they are to be used during the winter, they may be piled in heaps in a dry place, and covered with straw and earth. Wet injures them more than frost. (*Girardin and Debreul; See also Patent Office Report* 1844, p. 145; 1845, p. 321; 1846, p. 186; 1848, p. 159, 578.)

480. In the above references, much interesting information will be found. We would hardly, in our present state of agriculture, recommend this crop to be introduced into our rotations or upon rich soils, but we are confident that every farmer would find it profitable to set apart a field for this plant, and use the stalks in place of hay, and the tubers for his horses, sheep, milch cows, and hogs in winter and spring. There are certainly few plants which can be raised so readily, nor one which will yield more food at less cost. After a few years the artichoke will die out, in many localities; having exhausted the soil of the peculiar food it requires.

CHAPTER XVII.

PARSNIP (*Pastinaca sativa.*) CARROT (*Daucus Carota.*) BEET (*Beta Vulgaris.*)

481. The Parsnip is a native of England, of the Continent of Europe, and of Asia, but in its wild state is useless, if not poisonous. It has become naturalized as a wild plant in the United States, (*Gray;*) and when once established as a weed, is very difficult to exterminate, while the root diminishes in size. Formerly, it was in more general use than at present, and it is now more cultivated in Catholic countries than in Protestant. Shakespear refers to it in the old proverb that "smooth words butter no parsnips." It is cultivated both as a field and garden crop; and in the Channel Islands, (Jersey, Guernsey, and Alderney,) and in parts of France, it is greatly depended on for fattening hogs and cattle, and as food for milch cows, for all which purposes it is perhaps superior to any other root.

482. There is probably only one species, but several varieties, of which, in Great Britain and America, the *Large Jersey* is considered the best for field culture. Of this there are two sub-varieties, (*a,*) the *fusiform*, which strikes deeply into the earth, and (*b,*) the *napiform*, which becomes thick, and grows near the surface. French writers mention three varieties as worthy of attention; (*c,*) the *Coquaine*, with a long root, and tall leaves; (*d,*) the *Lisbonnaise*, with a shorter and thicker root; and (*e,*) the *Siam*, small, and of a yellowish tinge, tender, and richer in flavor than the others. Any of these, however, will degenerate in poor soil, or by careless culture.

483. Late examinations have proved this root to be more nutritive than the Carrot, while it greatly excels the latter in hardiness; freedom from disease and insects; in its adaptation to soils; in its yield; and facility of culture. We believe that it is far too much neglected, and were the *fashion* to change in our Northern States it would be greatly for the benefit of farmers.

All animals are fond of the Parsnip. To milch cows it is eminently favorable, giving a flavor and richness to their milk which no other winter vegetable but the Carrot can give. The cows of Jersey and Guernsey fed with Parsnips and hay, yield butter during the winter of as fine a tinge, and nearly as good flavor, as if they were fed in pastures. To horses it is equally suited as the Carrot. Hogs are extremely fond of it, and, when boiled, poultry may be fed upon it. (*Low.*) To this may be added, that next to the Artichoke, it bears frost the best of any of our cultivated roots, and it may be left in the ground through winter, not only without injury, but even with an apparent increase of saccharine matter.

484. No ultimate analysis of this root appears to have been made. (*E. T. Hemming*, 1852.)

485. Proximate analysis of the Parsnip root (*Voelcker*, 1852;) grown on stony, shallow soil, on the farm of the Royal Agricultural College, Cirencester, England.

	I.	II.	Average.
Water,	81.780	82.320	82.050
Inorganic matter, (ash,)	0.941	0.924	0.932
Nitrogenized organic substances,	1.310	1.250	1.280
Carbonaceous matters,	15.969	15.506	15.738
	100.00	100.00	100.00

or the same dried at 212° F.—

	I.	II.	Average,
Nitrogenized substances,	7.43	7.12	7.27
Carbonaceous matter,	87.41	87.65	87.54
Inorganic matters, (ash,)	5.16	5 23	5.19
	100.00	100.00	100.00

Parsnips contain 6 to 8 per cent less water than turnips, and 5 to 6 per cent less than mangolds. The quantity of flesh-forming substances

in fresh Parsnips is about the same as that contained in turnips. In a dried state, however, turnips are richer in protein compounds than parsnips.

486. Detailed proximate composition of Parsnips. *(Voelcker.)*

	In natural state.	Calculated dry.
Water,	82.050	
Cellular fibre,	8.022	44.691
Ash united with the fibre,	0.208	1.159
Insoluble protein compounds,	0.550	3.064
Soluble casein,	0.665	3.704
Gum and Pectin,	0.748	4.166
Salts insoluble in alcohol,	0.455	2.535
Sugar,	2.882	16.055
Salts soluble in alcohol,	0.339	1.888
Ammonia in the state of ammonical salts,	0.033	0.184
Starch,	3.507	19.537
Oil,	0.546	3 041

487. Inorganic analysis of the Parsnip. *(Richardson.)*

Potash,	36.12
Soda,	3.11
Magnesia,	9.94
Lime,	11.43
Phosphoric acid,	18.66
Sulphuric acid,	6.50
Silica,	4.10
Phosphate of iron,	3.71
Chloride of sodium,	5.54

By this it will be perceived that it belongs to the class of *potash plants*, but that it is also rich in the phosphates. The starch is all deposited in the external layers of the roots; the second layers contain much more protein compounds than either the heart or the outer layers. It will thus be noticed that the albuminous or protein compounds are not uniformly distributed throughout the whole mass of the root.

	In outer layers.	Heart.	Layers between the heart and the outer layers.
Per centage of nitrogen,	1.039	1.069	1.500
Equal to			
Protein compounds,	6.493	6.668	9.375

488. Parsnips succeed best in a deep, well pulverized, loamy soil, but will prosper in much heavier clays than carrots, especially if the soil is formed of granitic rocks. They require depth, and consequently the ground should be plowed deeply, or subsoiled, which is better still; but they will force their roots in spite of obstructions. Fresh barn-yard manure is not injurious to them.

489. The land being manured, (if requisite,) and plowed, is harrowed and rolled, and the seed sown broad-cast, by hand in rows, or by drill.* If by either of the first modes, it must be lightly harrowed, care being taken not to bury it above 1 or 1½ inches deep. It is important that the seed be fresh: if two years old it will not vegetate. In Jersey 3 or 4 lbs. *(Le Couteur)* in Scotland 10 lbs. *(Stephens)* per acre of seed are required. It generally vegetates slowly. Some soak it and mix it with damp sand to hasten germination, but in this case it should not be sown in dry land. If in drills, they should be just wide enough to admit a one horse plow or cultivator,—about 20 inches—and by degrees the plants must be thinned to 6 or 9 inches apart, according to the size of the variety, and the richness of the soil; but it is better to sow rather heavily to prevent misses. When the plants are one inch high they are to be weeded with a hoe, and the land must be kept clean in this manner till they are large enough to admit a cultivator. After this they grow very rapidly, and soon cover the ground with their leaves, and prevent the further growth of weeds.

The following plan is recommended, where a good drill cannot be procured. When the land is well harrowed and leveled, sow the seed broad-cast, harrow, and roll it; then when the plants appear, hoe into drills, either with a hoe-plow or hand-hoe.

The chief labor requisite, is keeping down the weeds till the parsnips gain sufficient size to do it themselves.

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*The Drills manufactured by Emery & Co., of Albany, N. Y., sow this seed regularly and at a proper depth.

490. Harvesting is most readily performed with a plow, with a blunt or worn out share, drawn by a pair of horses, along or across the rows. The pressure of the plow and earth forces the roots out of the ground, when they are gathered into baskets by hand. They may be left in the ground, if intended for winter use, as long as the frost will permit; and, if for spring use, through the whole winter. They may be kept in cellars, or as is recommended for artichokes.

491. In Jersey, the crop averages from 9 to 11 tons per acre, but has been known to be as great as 27 tons 8 cwt.

492. When the leaves begin to fade, they should be cut off and given to cows; but if they are moist from rain or dew they are apt to inflame the udder. A good armful a day to each cow will impart nearly as much richness to the milk as the parsnip itself.

493. Domestic animals will eat the roots raw, but hogs are believed to prosper better upon them if they are cooked. Pork made of turnips is said to be quite equal to that made of corn. *(See Trans. of N. Y. State Agricultural Society*, Vol. xi, p. 360.)

494. Wine has been made of this root, and a pure spirit may be obtained from it by distillation.

495. For seed, the plants should be allowed to stand till the second season, or the best roots may be set out two feet apart each way, the crowns being under the surface of the ground. In the latter mode from 1½ to 4 lbs. of seed may be expected from a square rod of 16½ feet. *(Stephens.)* The seeds ripen irregularly, and should be gathered by hand when ready, being spread under cover till quite dry.

The seeds are apt to produce blisters and watery vesicles on the hands and arms of those gathering them, which may be prevented by rubbing well with grease previous to commencing.

496. Neither insects nor disease of any kind appear to injure this plant in the United States.

497. The best manures, are rich dung, guano, bones in some form, wood ashes, plaster, and common salt. The inorganic compound should be drilled in with the seed.

498. THE CARROT—like the parsnip—belongs to the botanical order of *Umbelliferæ*, the Hemlock or Parsley family, some of the species of which are mutritive, and many of them poisonous. The wild carrot is a common weed in Europe, and is wholly useless, having a hard, slender, fusiform root. Mr. Low is inclined to think that our edible variety has been derived from warmer countries, and not from the wild plant of northern Europe, which no modern cultivation has been able to change. It was known to the Romans, and is described by Pliny. It was introduced into England, as a field crop, by Flemish refugees, towards the end of the 16th century. The varieties are very numerous, being divided into *(a,)* field, *(b,)* garden, *(c,)* red, *(d,)* white, &c., while the root varies in shape from fusiform to napiform. The most esteemed for field culture are the *(e,)* White Belgian, *(f,)* Altringham, *(g,)* orange, and *(h,)* long red carrot.

499. The culture of this root for the feeding of stock has rapidly increased both in America and Europe, during late years: still, with us, it is rare, and grown in small quantities. It requires a peculiar soil, and careful cultivation, and in its early stages is difficult to attend to. At the same time, it is nutritive, and when every thing is suited to it, very heavy crops may be grown.

Analysis appears to indicate that 350 to 400 parts of carrots are required to replace 100 parts of good meadow hay in feeding horses ; and this root is much inferior to the equivalent of potatoes, in practice. *(Boussingault.)* Thaer says that a working horse may be kept in condition on 70 or 80 lbs. of carrots, and 8 lbs. of hay daily.

500. No ultimate analysis appears to have been made. The organic matter, ash, and nitrogen have been found to vary as follows, calculated dry.

	Boussingault and Horsford.	Voelcker.	Way.		Fromberg.	
		Root.	Root.	Top.	Root.	Top.
Organic matter,		93.710	93.5	81.3	90.5	84.6
Ash,		6.290	6.50	18.7	9.49	15.4
Nitrogen,	1.34 to 3.61					
Water,		88.260				

501. Proximate analysis of fresh white Belgian carrot (A,) compared with the fresh parsnip, (B,) grown on same soils:—(*Voelcker*, 1852.)

	A.	B.
Water, - - -	88.260	82.050
Organic matter, containing nitrogen, -	0.596	1.280
Organic matter, fitted for the support of respiration and formation of fat,	10.399	15.738
Inorganic substances, - -	0.745	0.932

In round numbers, carrots may be assumed to contain about 88 per cent. of water, and 12 per cent. of solid matter.

502. Proximate analyses of the fresh (A) and dried (B) white Belgian carrots, (*Voelcker*,) at 112° F.

	A.	B.
Water, - - - -	87.338	———
Cellular fibre, - - -	3.471	27.412
Inorganic matters attached to fibre, - -	0.145	1.145
Sugar, - - - -	6.544	51.682
Salts soluble in alcohol, - - -	0.409	3.230
Gum and pectin, - - -	0.885	6.989
Inorganic salts insoluble in alcohol, - -	0.293	2.314
Soluble casein, - - -	0.498	3.934
Insoluble protein compounds, - -	0.169	1.334
Oil, - - - -	0.203	1.604
Nitrogen, in state of ammoniacal salts, -	0.008	0.063

503. Inorganic analysis of the white Belgian carrot (A,) (*Way*,) and of the parsnip, (B,) (*Richardson.*)

	A.	B.
Silica, - - - - -	1.19	4.10
Phosphoric acid - - -	8.55	18.66
Sulphuric acid, - - -	6.55	6.50
Carbonic acid, - - -	17.30	
Lime, - - - - -	8.83	11.43
Magnesia, - - -	3.96	9.94
Peroxide of iron, - - -	1.10	
Potash, - - - -	32.44	36.12
Soda, - - - -	13.52	3.11
Chloride of sodium, - - -	6.50	5.54
Phosphate of iron, - - - -		3.71

504. Dr. Voelcker (*Jour. Royal Agricultural Society of England, Vol.* xiii, p. 395,) thus compares the white carrots and parsnips together:—1. There is a general resemblance in the composition of both roots. 2. Parsnips contain less sugar than carrots, the deficiency of which is replaced by starch, not occurring in carrots. 3. Carrots contain an average of 12 per cent. of solid substances, parsnips 18 per cent. Thus parsnips will be found much more nutritious than carrots. 4. The flesh-forming constituent of parsnips is greater than that of carrots. Parsnips are about as rich in albuminous compounds as mangolds. Thus *fresh* parsnips contain 1.30 per cent. and *dry*, 7.25 per cent of flesh forming constituents; the above carrots, fresh, 0.612 per cent, and dry, 5.46 per cent. of the same. Parsnips also contain more nitrogen in the form of ammoniacal salts. 5. Parsnips contain a double proportion of fatty matters. 6. The difference in the relative proportions of cellular fibre in both roots is very great. The cellular fibre, occurring in carrots, parsnips, turnips, mangolds, &c., must not be regarded as useless in the animal economy; for there can be little doubt that the soft and young fibres of these roots are readily converted in the stomach of animals into gum and sugar, and applied in the system to feed the respiration, or for the formation of fat. 7. Parsnips possess greater value than white Belgian carrots as a feeding or fattening material. Parsnips are, indeed very valuable as an article of food; they are liked by cattle, and highly esteemed by Continental farmers for fattening stock. Moreover they stand the frost better than any other root-crop cultivated in England.

505. Carrots require greater care in cultivation, than any other plant of the sort. The soil must be light, sandy, rich, and fertile to the depth of at least a foot, to produce good crops. Freedom from weeds is also very essential, as the young plant

is delicate, and at first grows slowly. The ground should be plowed and prepared, as far as possible, in the fall, and the seed sown in spring, as early as the climate will permit:—Thaer says, "even before the winter is over, and while the snow remains on the ground," in Prussia. Manure adds much to the yield, but if dung be used, it ought to be well rotted or composted; or raw manure may be plowed in, in the fall, and compost *dragged* in, in the spring previous to sowing. In Scotland, it is applied at the rate of 25 tons to the acre, and placed in the drills immediately below the seed, *(Stephens.)*

506. The seed should be fresh, for if two years old it frequently fails. From $3\frac{1}{2}$ to 6 lbs. to the acre are required. As it germinates slowly, at the ordinary spring temperature, the following process is recommended. Enclose the quantity wanted in a bag, and soak in water for 48 hours—and this 8 or 9 days before sowing. After soaking, spread the seed about a foot in thickness on the barn floor, and germination will take place in 6 or 7 days. When the seed is observed to be "chipped," it should be sown, being previously mixed with fine dry sand, to about 4 pecks to the acre, seed and sand together. By drill is the best mode of sowing, the ground being previously rolled, and rendered very smooth; but it may be sown by hand, rows being previously marked out, and the seed covered with a hoe. Broad-casting would require so much expense in weeding, as to be entirely inapplicable. Seed dealers now prepare carrot seed by rubbing off the hairs or points; but where this is not done the seed may be separated by mixing intimately with sand or ashes; or rubbing forcibly between the hands. The seed should be slightly covered. In wet weather, it will penetrate the ground spontaneously. The rows or drills should be about 20 inches, and the plants 6 to 8 inches apart, according to the size of the variety. In such roots, nothing is gained by crowding, as much being lost in size, as is gained in number.

507. When the carrots show themselves, they should be raked,

hoed, and thinned; the hoeing must be repeated at least twice. When sufficiently large, so as not to be injured, the cultivator may be run between them, and the weeds kept down till the leaves cover the ground.

508. The leaves are of little value for feeding stock, cattle not liking them. Carrots may be dug with an iron fork, or by a blunt plow, as is recommended for parsnips, the tops being cut off. They are not injured by moderate frost, but when severely frozen they are apt to rot as they thaw. On the other hand, when put in large heaps, and kept very warm, they soon ferment and rot. The safest mode is to place them in layers alternately with straw, in cellars or heaps, ventillation being allowed till the approach of severe cold, when the heaps must be covered with straw or earth.

509. The following is the cost of raising a crop of one acre of carrots, at Fredonia, Chautauque county, New York, in 1848, on green sward turned under, rolled down, and harrowed with a fine harrow, and sowed on top of the sod, May 4th. (*Trans. of N. Y. Agricul. Soc'y*, vol. viii. p. 327.)

Plowing and harrowing 1¼ days, team $1.25				$1.88
Raking and sowing 10 days @62½ cents,				6.25
Hoeing and weeding	16 "	"	"	10.00
do second time	10 "	"	"	6.25
Harvesting	33 "	"	"	20.63
4 lbs Seed		40	"	1.60
Interest on land,				3.50
				$50.11
996 bushels carrots at 12½ cents,				120.75
Profit,				$70.64

70½ days of man's labor, and 1½ days of horse labor upon one acre of land. Twelve and a half cents per bushel is apparently a very high price, when the true nutritive value, and the quantity of water contained are compared with the price of oats, buckwheat, or some other roots.*

*If Oats are worth 37½ cents per bushel, Carrots are evidently too dear at 12½ cents, if the following mode of estimating the value of food is correct. We take equal weights of the two vegetables to be compared and find the equivalent proportions of nutriment in each. Thus:—

Oats	100 lb	Carrots 100 lb
Deduct water,	16 "	88 "
Solids left	84 "	22 "

510. The Carrot contains in place of starch, as also the turnip, a variable proportion of a gelatinous gummy like substance, to which the name of *Pectin* has been given. It is a tasteless solid, which swells up and gelatinizes with water. It possesses feeble acid powers, combining with bases to form *pectates*. It is represented by the symbol C_{12}; H_8 ; O_{10}. *(Solly.)*

511. The average crop in the the United States, with good cultivation, is from six to eight hundred bushels per acre. *(Wiggins.)*

The following crops of Carrots have been raised by L. Risley, of Fredonia, Chautauque Co., New York, allowing 55 lbs of the fresh roots to the bushel. (*Pat Office Reports* 1850, *p.* 385.) Mr. R. took the Premium of the State Agricultural Society, annually, for 10 years; so these may be considered *above* the average:

1	acre gave	1590¼	bushels,	at a cost of	$104.75, or	119½	days	labor	at 62½	cents.
½	"	498	"	"	25.76,					"
⅞	"	826½	"	"	42.69,					"
1	"	966	"	"	60.11 or	70½	"		"	"
1⅜	"	2318½	"	"	54.37					"
1	"	951½	"	"	46.63					"

With the exception of the first and fourth, the particulars are not given. The Carrots were sown in drills from 12 to 14 inches apart, and hoed as soon as the young plant could be seen. The plants were left from 2 to 4 inches in the row. In the cost of the first crop, $15.00 is charged for manure, and $10,50 for "Improvement of land"; the rest is the actual outlay for labor, and seed without interest. The charge for wages is unusually low.

Of this

Nitrogeneous matter forms	16	per cent,	- 13.44 lb	5	per cent	-	1.10 lb
Carbonaceous matter "	77	"	- 64.68 "	88	"	-	19.36 "
Ash "	3	"	- 2.52 "	6	"	-	1.32 "
Husk "	3	"	- 2.52 "				

Now, allowing that a bushel of Carrots weighs twice as much as a bushel of Oats, though 56 lbs per bushel is the usual estimate, 37½ cents worth of Oats contain over 6 times as much nitrogenous matter as 12½ cents worth of Carrots.
1¾ " " carbonaceous " " "
2 " " ash and residue " " "
but as the nitrogenous matter is by far the most valuable for common food, the Oats greatly overbalance the Carrots in value in this respect. In another point of view, i. e. the fattening qualities of the two, the dry Oat contains from 5 to 7½ per cent of oil, while the dry Carrot contains only about 1½ per cent.; so that in every aspect, except the supplying *fresh* food, in winter, to the animal, the Carrots appear to be very much overcharged at that price. As has been already mentioned, Boussingault, experimenting on a horse, places the value of Carrots compared with hay as 400 to 100; and hay being worth to the farmer for feeding or wool growing (*not for sale into cities*, in which case other elements of cost enter,) not more than $5 a ton, 100 lbs. of Carrots would be worth about 6 cents or 3¼ cents per bushel. Still, in proportion to Oats, this is too high. We offer this view of the subject for further consideration.

512. THE BEET belongs to the botanical order of *Chenopodiaceæ*, the Goose-foot family.

Spinach. (*Spinacia oleracea,*) and Lamb's-quarters, (*Chenopodium album,*) belong to the same family.

The original type of the garden and field-beet, is the *Beta maritima*, or sea-beet, a plant indigenous to the sea shore of many parts of Great Britain, especially where an argillaceous formation borders the sea-line; the root is somewhat fleshy, and the leaves are gathered and eaten. The cultivated varieties are the *Beta hortensis* or *cycla*, the Chard Beet, which is cultivated for its leaves alone; and the *Beta vulgaris*, which comprises all the red, white, and variegated beets, the root of which is of chief value, whether used for garden or field culture. Of both these, there are very many varieties in size, color, shape of the root, and mode of growth. The field-beet is generally known by the name *Mangel-Wurzel*, (German for "*Root of Scarcity;*") or *Mangold-Wurzel*, (which literally means, the "*Root of the White Beet;*") or it is simply, and more usually termed *Mangold.* Field-beets may be again subdivided into those which are cultivated for the feeding of cattle, and those from which sugar is made, which latter contain more saccharine matter, and are generally white.

Such sugar is now manufactured on the Continent of Europe, including Russia, to a very great extent; and the quantity is annually increasing, as Chemistry simplifies and renders cheaper the process. This manufacturing is said to have been lately introduced into Utah. The best varieties of sugar-beets are (*a,*) the ***Disette***, with a white root, skin and leaves, each root weighing from 25 to 34 lbs.; (*b,*) the *Silesian* beet, the sweetest, but smaller; (*c,*) the *Yellow* beet, (*d,*) the Siberian beet. (For a very minute and accurate account of the Beet-sugar manufactories of Europe, see *Knapp's Chemical Technology*: London Ed., 1851, vol. iii., pp. 339—416.)

In 1841, the production of Beet-sugar in Europe was estimated at 55,000 tons; in 1847 at 100,000 tons; in 1850 at 190,000 tons. In 1842 France produced 40 millions of kilogrammes, (=45,000 tons;) in 1853, 80 millions kilogrammes, (=90,000 tons.) This progress has been ow-

ing to improvements, chiefly chemical, each year in the manufacture. (*Ann. of Scien. Disc.*, vol. iv., p. 95.; *Silliman's Journal*, vol. xvi., N. S., p. 275.)

513. The Mangold can be grown successfully for sugar-extraction at all places between 45° and 56° N. Lat. in Europe. At Tobolsk, in Siberia, this crop is cultivated for food, but the root is supposed to contain a smaller proportion of sugar than than that raised farther south; judging from the effect of a warm climate on wheat, the nitrogenous matter should likewise be smaller. The Sugar or Silesian Beet is more particular as to climate, and consequently does not succeed so well in general cultivation. *(Prof. Wilson.)*

514. The *root* of this plant is not strictly a *true* root, but a thick fleshy protuberance of the stem, to which the actual roots are attached. The bulbous portion of some kinds of beet is formed below the surface of the earth; in others, it is above, exposed to the air; and again, in some it is placed midway between earth and air. Most varieties are spindle shaped; some, long and narrow, like the radish; others thicker, and more round; some nearly square, with deep indentations; and seldom flattened. The varieties are also distinguished by the leaves, curled or smooth; light or dark green; fringed with red; or entirely red.

515. If a root is cut across, it will be seen to be composed of concentric zones or layers of fibrous vessels and cellular tissue differing in color more or less according to variety. It will be remarked, that the leaf-stalks take their origin pretty deeply in the body of the bulb, and there form an extensive region called *the heart*, characterized by its greenish color and abundance of fibrous vessels; and, chemically, more analogous to the leafstalk than to the rest of the bulb. The actual bulbous matter is distributed in a zone about this heart, extending below it to the point. The exterior, or skin, is composed of a peculiar compact cellular substance, containing mineral and nitrogenous matter;

immediately beneath which lies the herbaceous tissue, containing the coloring matter, an essential oil, and several other peculiar organic compounds; then succeed the concentric zones of vascular and cellular tissue. In the cellular tissue is deposited the saccharine matter, the proportion seeming to be greatest in those cells immediately in contact with the vascular tissue. The *germ* (where the leaves enter the bulb) contains a large proportion of the saline matters, but no sugar. The cells contain neither starch, nor crystalline salts, but only a liquid, consisting chiefly of dissolved sugar. The fibrous vessels, on the other hand, contain no sugar, at least those do not which are situated in the heart, but they contain salts in a crystalline form. Some 25 or 30 distinct substances are found in this root.

516. In Great Britain the root is held in high estimation as a fallow-crop, and as food for fattening stock; and the culture is understood to be increasing. No statistics regarding it in the United States appear to exist. We are inclined to believe that this crop is annually becoming more common in the Atlantic States.

517. Ultimate analysis of the root, (A;) and leaves, (B;) of the Mangold. *(Boussingault.)*

	A.		B.
	I.	II.	
Carbon,	42.75	42.93	38.1
Hydrogen,	5.77	5.94	5.1
Oxygen,	43.58	43.23	30.8
Nitrogen,	1.66	1.66	4.5
Ash,	6.24	6.24	21.5

The leaves appear to possess a far higher value, both as a *feeding*, and as a manuring substance, than is usually assigned to them. The proportions of water were about the same in each; and the analysis shows that, in a chemical point of view, the leaves were *three* times as valuable as the same weight of roots would be. *(Prof. Wilson.)*

518. Proximate average of several analyses of Mangold. *(Knapp.)*

Sugar,	10
Soluble salts, pectin, certain azotized compounds, &c.,	3
Water,	83
Woody fibre, insoluble salts, albumen, and other azotized compounds,	4
	100

519. Proximate analysis of Mangold—"Sugar Beet."—*(Horsford and Krocker.)* Root grown at Giessen:

	Fresh.	Dry.
Albuminous matter,	2.04	11.5
Sugar,	12.26	68.8
Cellulose and other nitrogenous substances,	2.56	14.6
Mineral substances,	0.89	5.0
Water,	82.25	

520. Inorganic analysis of Mangold. *(Way.)*

	Tops.	Roots.
Silica,	1.99	2.57
Phosphoric acid,	5.15	3.08
Sulphuric acid,	5.8	3.37
Carbonic acid,	6.49	18.32
Lime,	8.65	1.95
Magnesia,	8.66	2.11
Peroxide of iron,	0.96	0.6
Potash,	21.26	24.79
Soda,	7.01	13.75
Chloride of sodium,	33.96	29.41
Per centage of ash,	1.7	0.886

Payen found 1.11 per cent of nitrogen in dry beet, of which one-third was due to the albumen. Horsford, obtained from beet-root, which lost in drying 82¼ per cent of water, 1.8 per cent of nitrogen. Under the very probable supposition that all these nitrogenous substances are of an albuminous nature, these numbers would correspond with 11.54 per cent of albuminous matters, or 6.16 per cent of the amount of sugar. *(Knapp.)*

As will be noticed above, Chloride of Sodium (common salt) enters largely into the composition of the Mangold. Prof. Way gives the following comparative table of the quantity of salt yielded by *one ton* of each of these plants:

	Roots.	Tops.
Mangold Wurtzels, - -	5.29 - -	12.82 per cent.
Carrots, - -	1.42 -	11.25 "
Turnips. - -	1.49 - -	6.15 "

521. The average quantity of nutritious matter afforded by a crop of Mangolds of 20 tons, or 45,000 lbs. per acre, consists of 900 lbs. of husk or woody fibre; 4,950 lbs. of starch, sugar, &c; 900 lbs. of gluten, &c; and 450 lbs. of saline matter, or ash. No oil or fatty matter has yet been detected in an appreciable quantity. *(Johnston.)*

522. This crop prospers on much heavier soils than either turnips or carrots; but a light clay soil, containing a fair proportion of humus, and rendered rich by manures, is the best. Moisture, especially in the beginning of the season, is very necessary, in order to develop its full size and good qualities. An excess of moisture is very rapidly absorbed by beet roots.

523. In France, it is a common practice to sow the seed in a seed-bed, and afterwards transplant. In England, the soil is plowed twice in the fall, laid up dry in the winter, manured and plowed again in the spring. With us one plowing is generally considered all that is required. Depth and friability are necessary in order to procure large crops, and the sub-soil plow may be used to great advantage. The land must be thoroughly harrowed, and the seed drilled at the rate of 3 or 4 lbs. per acre, not more than *one inch* in depth, and from 12--14 to 24 inches apart. Sowing may take place as early as frosts will permit. The seed should be steeped from 12 to 24 hours in water, to cause rapid germination; though if the soil and season are very dry, this may prove injurious. The subsequent cultivation consists of hoeing, and using the cultivator, keeping the earth fresh and perfectly clean. When well up, the plants must be thinned. Many leave the plants too close to each other, which interferes with growth, hoeing, and cleaning. If planted 2 feet apart, there will be a produce on the acre of 10,890

plants; that is both two feet apart, lengthways and breadthways.

According to Boussingault, the culture of a hectare (=2.471 acres,) of sugar-beet, requires, in France, the labor of a man for 113 days, and of a horse for 35 days; but much of this labor might probably be saved by a better system of management and improved implements.

524. The peculiar organization of this root requires great care to be exercised in harvesting the crop, as the slightest injury to it is sure to be followed by a tendency to decay when it is stored. At the same time, it keeps well to a late period of summer if carefully stored without injury by frost, or rain, or mechanical causes. The beets which grow above the ground are best gathered with the hand; kinds that grow underground require to be loosened by running a plow along the drill. The tops are then carefully cut off, without injuring the *heart*. In Alsace, it is the custom to take away the leaves, and trim the roots upon the ground, the refuse, which is a valuable manure, being plowed in immediately. Or the leaves may be fed to cattle, though they are said not to be very fond of them. Fine weather should be selected for the operation, and especial care must be taken to preserve the roots from wet and frost. It is desirable that they should be exposed on the ground, for three or four days before they are stored away, in order that they may lose as much of their moisture as possible.

525. Various modes of preserving them are used, such as *(a)* storing in pits dug in the ground, 4 to 5 feet deep, and covering with straw, and a thick layer of earth. To insure ventillation, narrow ditches or gutters are made in the soil under the heap, and chimnies are formed by inserting stakes to be afterwards withdrawn. Or *(b)* the roots are piled between two rows of hurdles, set up at 6 or 8 feet apart, and then built up from the top of the hurdles in a long pyramidal form. A second row of hurdles is then set all round, at a distance of 9 inches from the other, and the space between the two filled with loose straw well

pressed down. A good thatch is laid over the centre. In our Northern States, the most economical plan, when this crop is to be regularly cultivated, would probably be the preparation of root houses, or cellars under barns on hill sides.

526. The crop varies very much according to soil, manure, and cultivation. In France, the average maximum is about 278 cwts. per acre; the minimum 67 cwts. per acre. Boussingault gives, for the same country:—

	Tons.	Cwts.	Qrs.	lbs.
Pas de Calais, - -	12	9	1	19
Department of the North, - -	12	10	2	25
Department of Cher, - -	15	1	39	

or an average for the whole country of 10 tons, 9 cwt. 1 qur. 13 lbs. per acre. In England as high as 39 tons, 13 cwts. per acre have been procured, by not applying manure *directly* to the crop; but 20 tons are considered a good average on soils yielding 5 quarters (=46 American bushels,) of wheat to the acre. Wiggins gives the yield, in Delaware, of the Silician Sugar Beet at 800 bushels per acre, but a premium crop was grown in Monroe County, New York, of 1,489 bushels per acre, of 50 lbs. per bushel (=37½ American or 33 English Tons,) at a total cost, including manure, of about $22,00. *(Trans. of N. Y. Agricul. Soc'y. vol viii. p.* 328.

527. Cattle are readily fattened on this root. Late experiments in Scotland have proved Mangolds to be as profitable for this purpose as any other food that can be given. Steers weighing 935 lbs. live weight, consumed 120 lbs. of Mangolds per day, divided into three feeds, and 7 lbs. of straw besides. In 100 days each animal gained 161 lbs. *(Trans. of High. and Agricul. Soc'y. of Scotland* 1853.*)*

528. Manures act very variably upon this root. Ammoniacal manures increase the size and yield, but injure the sugar, while organic manures add to the sugar, but the crop is smaller. Guano is beneficial if the roots are intended for feed. Common salt is specifically beneficial, and should be applied in moderate

quantities under nearly all circumstances. It appears to be best to apply barn-yard manures to the previous crop.

An instance is given where an application of 3 cwt. of salt to the acre increased the crop from 26 to 40 tons.

The Beet at all stages of its growth, including the period of its flowering, exhibits the same relative proportions of water and solid ingredients; consequently half grown and full grown bulbs, flowering and not flowering plants, leave very nearly the same amount of dry residue. With the period of bearing seed, this residue rapidly diminishes in quantity. But the separate constituents vary in proportion. Thus, the Sugar gradually increases with the growth, attains a maximum at a certain period before ripening, when it again diminishes, and disappears with the formation of seed.

529. In England this root is frequently sold at £1 (=$4.88) per ton, but the *real* value to the farmer for feeding, is estimated at about one half, or $2.00. In this country, where meat brings a lower price, the value is of course less. The improvement of the land, when properly cultivated, ought, however, to be estimated as a profit.

530. No peculiar diseases or insects appear to injure this crop in the United States. In Europe, there are several of both, and of late in France it has suffered from a *Rot* similar to that of the Potato.

531. A sort of beer is sometimes made of it, at a low cost.

A good vinegar may also be procured by grating the root, expressing the juice into a barrel, and allowing it to undergo fermentation in a warm place. Six gallons have been made from a bushel of the root of the Sugar-beet. A cider-mill might be used for the purpose.

As this root is the raw material of an extensive manufacture, which demands great scientific skill, its culture and peculiarities have been thoroughly studied; and more, probably, has been written upon it than almost any other vegetable product whatever except wheat. In these pages, we have only been able to give a compressed abstract, and therefore refer the reader to the following works among many others. Thaer's Principles of Agriculture; Johnston's Agricul. Chemist.; Journ. of Royal Agricul. Socy. of England, vol. xiii.; Pat. Off. Reports 1849; British Farmers' Magazine vols. xxii, xxiii.; Knapp's Technology vol. iii.; Journal d' Agriculture pratique, Tome vii. Low's practical Agriculture, Stephen's Farmer's Guide; Wiggin's American Farmer, &c., &c.

CHAPTER XVIII.

SWEET POTATOES, (*Convolvulus Batatas.*) MUSTARD, (*Sinapis nigra and alba.*) HOPS, (*Humulus Lupulus.*)

532. The Sweet Potato, belongs to the order *Convolvulaceæ*, the *Convolvulus* or *Bindweed* family, of which the common Morning Glory of the gardens *(C. purpureus,)* may be mentioned as a type. The *Yams* of South America, and the medicine *Jalap* are also of the same genus. The Sweet Potato is biennial, growing with a large, long shaped bulb at the root.

533. As an agricultural plant, it may be considered as properly belonging to warm climates, but can be cultivated profitably, on suitable soils, as far north as Michigan. In New Jersey, large quantities are annually grown; but in all the northern States, the plant rapidly degenerates, and must be replaced by fresh bulbs from the South. In the southern States, this plant takes the place of the common potato, and is used not only for man's food, but for cattle, hogs, &c. It is there raised with great ease, and returns from 200 or 300 to 1500 bushels per acre, according to soil and climate. *(Patent Office Reports, 1845, pp. 452, 453.)* In this present article we shall confine ourselves to its culture in the North.

534. The only analysis of this root with which we are acquainted is one made in the West Indies, *(O. Henry.)*

Starch, - - - - - -	133
Albumen, - - - - - -	9
Sugar, - - - - - -	33
Cellular matter, - - - - - -	68

Fixed oil, - - - - - - -	11
Malic acid and salts, - - - - -	14
Water, - - - - - - -	732
	1,000

535. This plant requires a sandy, rather light, deep, and well stirred soil, which must be located on a dry subsoil; and the whole either naturally rich in organic matter, or rendered so by manuring. Stiff clay does not suit it. Slips or sprouts, from the previous year's tubers, are used for planting, and these are prepared in either of the following manners, *(a.)* In a bed of earth, make a box with planks set edgewise, and fill in about a foot in depth of good warm horse-stable manure, over which spread two inches of fine rich earth; on this lay the potatoes so near as to almost touch each other, and cover them from 2 to 2½ inches deep with the same earth. If the nights are cold, this bed must be carefully covered with straw, or some other warm covering, which is to be removed during the day. There is a danger in making the bed too warm, and so spoiling the roots. They must be kept tolerably wet after the sprouts appear: when these are 3 inches long, they are fit to set out. *(b,)* Dig a hole a foot deep, the size of the space required, and fill in with manure from the horse-stable, sufficient to make a good hot-bed. It should be raised 10 or 12 inches above the surface of the ground, and the top of the bed should be sand and loam. Place the potatoes in rows, about 6 inches apart, and cover them to the depth of 2½ or 3 inches. Afterwards proceed as above.

536. The ground should be plowed very deep, and thrown up in ridges or hills; if the latter, such as common potato hills, after they have been hoed. This should be done immediately before planting, so that the soil may be moist and fresh. Set two plants in a hill, 2 or 3 inches apart, and make the top of the hill sufficiently hollow to hold a pint of water. If there is

no rain, watering in the evening is requisite for a few days. If in ridges plant the slips 8 or 10 inches apart. When the weeds begin to appear dig or plow between the rows, clean round the plants with a hoe, and draw a little dirt round them. When plowed the last time — about the last of July — hill them up. If the vines have grown across the furrows, turn them carefully back, and afterwards replace them. No earth should be allowed to fall upon the vines; and if they root, they should be pulled up, otherwise small and worthless potatoes will be produced at each root, and the main ones will be inferior in size. They should be dug as soon as the frosts kill the vines.

537. There is great difficulty in the north, in preserving these tubers from decay during winter. The best mode appears to be placing them in moderately sized boxes, and keeping them, in a room sufficiently heated to prevent frost, at an equal temperature; allowing them, however, to "sweat" before packing them away. *(See Patent Office Report*, 1846, pp. 450-457. *Trans. of N. Y. Agricultural Society*, Vol. viii, p. 426.)

538. Mustard. *(Sinapis nigra, and alba.)* This plant is very rarely cultivated in the United States, except on a small scale; most of the mustard consumed in this country being imported from England, where the manufacture is confined to a very few localities. There are or were mustard manufactories in Philadelphia and New York, but the seed was chiefly imported from Holland and Germany. The *Black* mustard is preferred for this purpose, but becomes a very troublesome weed when cultivated. Of late years, the *White* mustard has been sown in rich soils in England for sheep feed during summer, for which purpose it is found to be profitable, but in the United States both the climate and the Turnip Flea are injurious to it. This species cannot become a weed, as it is killed by a very slight frost. It is occasionally used medicinally; and in Europe oil

is extracted from it at the rate of 36 lbs. of the white, and 18 lbs. of the black species from 100 lbs. of seed. *(For a very complete account of this plant see Patent Office Report*, 1845, pp. 312, 397, 959-966 *; compared with Ib.* 1848, p. 160.)

539. THE HOP is a native of the United States *(Gray,)*; but the cultivated varieties, of which there are many, are believed to have been introduced from England, in which country it is likewise indigenous.

540. The only uses to which it is usually put are in medicine and the imparting a bitter principle to malt liquors; and in the United States the chief field of cultivation has been New York. It was introduced into England from Flanders in the reign of Henry VIII, A. D. 1509–1547; and in that country it is grown chiefly in the counties of Kent and Sussex. The quantity produced in New York in 1840, was less than half a million pounds; in 1850, 2,500,000 lbs, which exceeds five-sevenths of the whole crop of the United States.

New York also stands foremost in the production of ale, beer, and porter. The breweries of the State produced in 1850, 645,000 barrels of ale, &c., being more than a third of the quantity returned for the whole Union. (*Census Report Dec.* 1, 1852, p. 75.)

541. The hop is a perennial, the stems dying each winter, and being reproduced. The male and female flowers are on different plants, the latter only being of use; but a few male plants are generally grown among the others. The flower is the part used; the active principle,—a waxy yellow powder, called *Lupulin*,—being produced under the scales of the strobiles.

542 The following analysis of the Lupulinic grains, and of the scales, are copied from *Pereira's Elements of Materia Medica.*

Lupulinic grains.				Scales.
PAYEN, CHEVALLIER, and PELLETAN.		IVES.		PAYEN, &c.
Volatile oil,	2.00	Tannin,	4.16	Astringent matter.
Bitter principle, (Lupulite,)	10.30	Extractive,	8.33	Inert coloring do
Resin,	50 to 55.00	Bitter principle	9.16	Chlorophylle.
Lignin,	32.00	Wax,	10.00	Gum.
Fatty, astringent, gummy matters, ozmazome, malic and carbonic acid, malate of lime, acetate of ammonia, chloride of potash, sulphate of potash, &c.,	traces.	Resin,	30.00	Lignin.
		Lignin,	38.33	Potash, lime, and ammonia with acetic, hydrochloric, sulphuric, nitric, &c. Acids.
				Lupulinic matter.
	99.30		100.00	

543. Inorganic analysis of the Hop (A;) and Leaves (B;) and Bind or Stem (C;) of the Hop Plant. (*Nesbit.*)

The 2 lbs. of Hops, dried at a steam heat, lost 3 oz. of moisture, leaving 1 lb. 13 oz. of dry hops. These furnished 1282 grains of ashes, or nine-tenth per cent.—9⅜ oz. of leaves, dried, lost 1⅛ of moisture, leaving 8¼ oz. of leaves. These left 572 grains of ashes, or 16⅓ per cent.—1 lb. 2½ oz. of the Bind, dried, lost 1⅞ oz. of moisture, and left 1 lb. 0⅝ oz. of dry Bind. These gave 353 grains of ashes, nearly 5 per cent.

	A	B	C
Silica,	21 50	12.14	6.07
Cloride of Sodium,	7.24	9.49	6.47
Chloride of Potassium,	1.67	——	9.64
Soda,	——	0.39	——
Potash,	25.18	14.95	24 35
Lime,	15 98	49 67	38.73
Magnesia,	5.77	2.39	4.10
Sulphuric acid,	5.41	5.04	3.44
Phosphoric acid,	9.80	2.42	6.80
Phosphate of iron,	7.45	3.51	0.40
Per centage of ash, (dried)	9.87	13.06	3.74

544. Amount of inorganic matter removed from the soil by an acre of Farnham Hops. (*Nesbit.*)

The number of hills to an acre varies in different localities. In some places 1000, in others 1260, in other 1440 hills to the acre. The following is estimated from actual analysis of 4 hills, at the rate of 1000 per acre. (*Nesbit*)

	500 lbs. Hops ℔	oz.	146½ lbs. Leaves ℔	oz.	239 lbs. Bind ℔	oz.	Total Plant ℔	oz.
Silica, - -	9	9	2	2	0	9½	12	4½
Chloride of Sodicum, -	3	3½	1	10	0	10	5	7½
Chloride of Potassium,	0	12	—		0	15	1	11
Soda, - -	—		0	01	—		0	1
Potash, - -	11	3½	2	10	2	6	16	3½
Lime, - -	7	1¼	8	10	3	13	19	8¼
Magnesia, - -	2	9	0	6	0	6½	3	5½
Sulphuric acid, -	2	6¾	0	14	0	5¼	3	10
Phosphoric acid, -	4	6	0	7	0	9½	5	6½
Phosphate of iron,	3	5	0	10	0	0¾	3	15¾
Total,	44	8	17	6	9	11½	71	9½

545. There are several varieties, of which the *Farnham*, the *Golding*, the *Yellow Grape*, are considered the best.

These are found to differ much in the *proportion* of their inorganic constituents, and consequently the above analyses must only be considered as an approximation as regards the species, while it is accurate as regards one variety. *(See Stephen's Farmer's Guide. vol. ii, p.* 45, 320.*)*

546. The soil peculiarly adapted to this plant is a rich, deep, rather adhesive clay, with abundance of organic matter, or vegetable mould; and a porous rocky subsoil. A drý subsoil is considered essential. The variety grown, and the quality of the produce depend entirely upon the character of the soil; and the peculiarities from these causes are almost as numerous as they are in wine-culture. In England, large quantities of valuable manure are expended on hops; such as bones, woollen rags, &c. The following, for the inorganic portion, may be given as a sample:—*(Journal of Royal Agricul. Society,* 1846, *part* 1.*)*

	I.	II.	
Guano, - -	3 cwt.	1 cwt.	per acre.
Common Salt, -	1 "	1 "	
Saltpetre, (or - -	1½ "	—	
Silicate of Potash,) -	1½ "	—	
Plaster, (gypsum,) -	1½ "	1½	
Superphosphate of lime, -	—	1½ "	
Pearlash, - -	—	1 "	

It may be laid down as a principle, that the more richly hops are manured, the better will be the quality and yield.

547. The culture of this plant, the picking, drying, packing, &c., demand a great outlay of labor, much skill, and more experience; and it would be useless to attempt to teach the practical manipulations in our limited space. We must therefore refer the reader anxious to know more of the subject to other works, and recommend those who wish to to cultivate the hop to visit a plantation, and thus acquire on the spot the necessary knowledge.

548. Hops are planted in hills; and long poles are driven in for the bind to climb on. They do not come to full bearing till the third season after planting, and will yield profitably from 12 to 20 years. In the United States in a good season, each hill will average 2 lbs. of hops ready for market; but more frequently the produce is below that. Appropriate buildings and kilns are necessary for drying, as well as peculiar baskets, cloths, bags, &c. The price is subject to very great and sudden variations; and the grower must have a large number of workmen at his command, as the crop, when ready for picking will not permit delay without serious injury. *(For a very complete account of hop culture in the United States, see Wiggins' American Farmer, and Trans. of N. Y. Agricultural Society, Vol.* iv, p. 447, &c.)

549. Cost of cultivating 2 acres of hops at Morrisville, N. Y. (*Trans. of N. Y. Agricultural Society*, 1845, p. 497.) The soil was a mixture of dark loam and gravel, well adapted for grass. It was well plowed and manured with 40 loads of barn yard manure per acre, and planted with hops and corn. The next season the account stood as follows :—

41 loads of manure put in hills, - -	$30.00
Rise of poles, - - - -	45.00
Labor of cultivating, - - -	40.00
Interest on land, - - - -	14.00
Harvesting and bagging, - - -	87,50
	$216.50
Produce of 2 acres, 2500 lbs. at 12½ cents, -	312.50
Net profits, - - - -	$96.00

CHAPTER XIX.

ONIONS, PUMPKINS, TOBACCO, CASTOR-OIL BEAN, LIQUORICE, UNCOMMON PLANTS.

550. THE ONION *(Allium Cepa,)* though usually ranked among roots (bulbous roots) is in reality a bud, formed at or underneath the ground, and whose scales are thick and fleshy. It is a biennial.

There are several species known in garden culture as Garlic, (*Allium Sativum*); Rocambole, (*A. Scorodoprasum*); Chive, (*A. Schœnoprasum*);* Leek, (*A. Porrum*); Shallot, (*A. Ascalonium*); and several varieties of the first (*A. Cepa*), as the Top onion (*A. Viviparum,*) bearing perfect bulbs or buds in place of seed; the Potato onion, producing by the formation of young bulbs on the parent root, an ample crop below the ground; red, white, yellow onions, &c., &c. There are five species indigenous to the northern United States, (*Gray,*) which sometimes become very troublesome weeds in pastures, in consequence of being eaten by cows, and flavoring the milk. The medical plant *Squills* belongs to the same family.

551. The native country of this esculent is unknown, but it has been cultivated from a very remote antiquity; as we find it—in its different species—the common food of the Egyptians in the time of the Pharaohs, before the Exodus of the Israelites. It is now cultivated in all parts of the world. In Hindoostan it is considered sacred, and not eaten. In Europe, the Portugal onions are the finest. In the United States, the *field culture* of the onion is chiefly confined to limited districts of Connecticut, Massachusetts, New Hampshire, and New York, certain towns

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*Found growing wild on Lake Superior, by Prof. Agassiz. Also a native of the Alps, to the height of 7000 feet. (*Agassiz L. Superior*, p. 166.)

being celebrated for the quantity of good onions which they produce and export. What are not required for home consumption are sent chiefly to the West Indies and South America. The census takes no notice of this plant. From 1835 to 1845, 30,000 to 40,000 bushels and from 1850 to 1853 from 125,000 to 150,000 bushels a year were raised in the town of Danvers, Massachusetts, alone; and though, to the *farmer* it is rather an insignificant product, yet it employs many men and women in its culture, and adds largely to the comfort of the small cultivators of New England. Its moral effect is beneficial, as it teaches the value of manure, of clean, neat cultivation, and steady industry; and it is said that onion-growing districts are always remarkable for their prosperity, economy, and intelligence.

552. Onions do not appear to have been accurately analysed. They owe their peculiar odor and flavor, as well as their pungent and stimulating qualities, to an acrid volatile oil which contains sulphur. When eaten, the oil becomes absorbed, quickens the circulation and occasions thirst. According to *Fourcroy*, *Vauquelin* and *Le Grange*, the following is the composition:—

Acid volatile oil,	Starch,
Uncrystallizable sugar,	Woody fibre,
Gum,	Acetic and phosphoric acids,
Vegetable albumen,	Phosphate and carbonate of lime,
Sulphur,	Water.

The nourishing quality probably depends on some unknown property of the oil, or an alkaline base, resembling *creatine* in meat; and may be classed with such sustaining substances as chocolate, opium, &c., of the principle of which we are yet totally ignorant. The ashes contain alkaline and earthy salts. This plant is used medicinally as a local irritant both internally and externally; as an expectorant, diuretic, and anthelmintic. Garlic is the most active of the family in its properties.

553. The soil should be mellow, dry and rich: it need not,

necessarily be deep. A rich sand, sandy loam, or gravelly loam, when well manured will answer. Onions do not appear to exhaust the soil, and may be grown for many years in succession without deteriorating. The following is the mode of culture pursued in Danvers, Mass, (*D. Buxton, Jun., in Farmer's Companion and Horticultural Gazette*, Vol. ii, p. 86; iii, No. 3.)

Such land is selected as would give a good crop of corn; wet land will answer if the seed can be got in by the first of May. It must have been plowed from the sod at least three years, unless a crop of carrots was raised the second year. Land may be rich and well manured, and yet not bear onions the first year of planting; afterwards the crops will be good as long as the land is kept well manured. Six or seven cords of good barnyard manure per acre are sufficient. Salt mud and "musselbed" are valuable for a change. Ashes, particularly on new land, are beneficial. The land is plowed shallow, rendered fine, and rolled as early in spring as the climate will permit, and the seed is sown in drills 10 or 12 inches apart by a machine made for the purpose. With it, a man can sow two acres a day, and drop the seed thick or thin. New land requires 3 lbs., old land 2½ lbs. of seed per acre; the young plants being more likely to live on old than on new land. Weeding is performed with a wheel-hoe (which costs about $1,) two or three times before the plants are large. A man can weed 1½ acres per day. The rest of the weeding is chiefly done by boys, and the expence depends on the management of the land the first year or two; it being of the utmost importance not to allow any weed to go to seed. The crop must be kept perfectly clean. When the stalks shrivel, and fall spontaneously, the bulbs have ceased to grow, and should then be pulled up and laid on the ground for some days to dry. If the weather is moist they must be turned. After this they must be spread in the barn till thoroughly dried, and then wove into ropes, or the stalks cut off before putting in barn, and the onions, when dry, packed in barrels.

554. In selecting onions for seed, take the largest and those which ripen the earliest, as by so doing the crops will ripen in warm weather. If no care is taken, onions will soon run out, ripening late, and growing with large stiff necks in October. In Massachusetts they should be harvested and dried by the first of August.

555. The average crop at Danvers is about 450 bushels per acre, though 600 or 700 are not uncommon, and occasionally 1000; the wholesale price from 40 to 50 cents per bushel. An instance is given in the *Albany Cultivator*, where 1209½ bushels of carrots, and 630 bushels of onions were raised off the same acre.

556. In Russia, the Potato Onion is cut into 4 parts, leaving the quarters hanging together at the root, the onions having first been hung up and dried in the smoke. Smoking, however, is not necessary. The quarters thus united are planted, and produce 4 fine onions. This course has been successfully pursued for thirty years, resulting in abundant crops. (*Pat. Office Report*, 1847, p. 188.)

557. In Vermont, New Hampshire, and north Massachusetts, a maggot has, of late years, proved very destructive to this plant. It is the young of the Onion Fly, (*Anthomyia Ceparum*,) which lives in the roots and causes them to perish. It appears to be the same insect that destroys the onion in Europe, and has probably been imported. It lays its eggs on the leaves of the onion, close to the earth, so that the maggots, when hatched, readily make their way to the heart of the onion. They come to their growth in about two weeks, turn to pupæ within the onions, and come out as flies a fortnight afterwards. It is said that the onion crop may be preserved from the attacks of this fly by sowing the seed on ground upon which a quantity of straw has been previously burned. (*Harris' Treatise on Insects*, p. 494.) In Scotland, the evil is remedied by dusting

the soil with dry coal soot once a fortnight. *(London Gardener's Chronicle, May* 26, 1853.)

558. Besides this, onions appear to be free from the attacks of insects and disease. It sometimes happens that many of the plants grow with thick stems and small bulbs. These may be left in the ground during the winter. Many of them will stand the frost, and in the spring they may be taken up and set in a bed where they will grow to be good onions.

559. The Pumpkin, *(Cucurbita Pepo,)* is the only plant of this family usually cultivated as a *field crop;* though in many parts of the United States, the other genera might be grown in the same manner with facility.

The Cucumber, (*Cucumis sativus*); the Musk Melon, (*C. Melo*); the Water Melon, (*C. Citrullus*); the Round Squash, (*Cucurbita Melopepo*); the Long Squash, (*C. verrucosa*); the Orange Gourd, (*C. aurantia*); and the Vegetable Marrow, (*C. ovifera*); the Bottle Gourd, (*Lagenaria vulgaris*); the Balsam Apple, (*Momordica Balsamina*), belong to the same family. There are two species indigenous to the northern United States,—The One-seeded Star Cucumber, (*Sicyos angulatus*); and the Wild Balsam Apple, (*Echinocystis lobata,*) (*Gray.*) The *varieties* of this family are exceedingly numerous, and they hybridize with great facility, even among different genera, as the cucumber and pumpkin, &c. The Pumpkins and Squashes are natives of America, and were unknown in Europe previous to the time of Columbus. The early voyagers found them in common use among the Indians through the whole extent of country from Florida to Canada, and probably far to the west. Melons and Gourds are derived from Southern Asia. Persia has long been famous for the former. (*Dr. Harris in the Trans. of the Amer. Asso. of Science.*) In medicine, Colocynth, (*Cucumis Colocynthus*), and Squirting Cucumber, (*Momordica elaterium,*) belong to this family.

560. Although this plant is so so generally cultivated, and enters so largely into the winter food of animals and men throughout the Western States, and notwithstanding that it has acquired a national importance in New England, very little information has been collected regarding it, and we are unable to meet with an analysis of it. Cucumbers and melons have been more fortunate, and we shall quote these as presenting a family

resemblance. The pumpkin probably owes its chief value to the sugar and starch which the flesh contains, and the oil in which the seeds are rich. For fattening, the latter appear to be chiefly of value. This plant probably contains a less per centage of water, than any of the rest of the family; but that per centage must still be large. There is a *sweet* variety, cultivated in gardens, which promises to be more profitable as food than the common sorts, though it does not usually grow to as great a size, and we recommend its adoption in the field.

561. The per centage of water, dry matter and ash, in the Musk Melon, (A,) and Water Melon, (B,) *(Salisbury.)*

	A.	B.
Per centage of water,	90.987	94.898
do dry matter,	9.013	5.102
do ash,	0.271	0.248
do ash in dry matter,	3.007	4.861

36,900 lbs of Musk Melons, and 40,322 lbs. of Water Melons contain each 100 lbs of inorganic matter or ash, as follows:—

	100 lbs. ash of Musk Melon.	100 lbs. ash of Water Melon.
Carbonic acid,	11.55	11.42
Silicic acid,	2.20	1.21
Phosphoric acid,	25.40	14.93
Sulphuric acid,	3.90	1.63
Phosphate of iron,	2.30	4.52
Lime,	5.85	7.32
Magnesia,	0.60	1.31
Potash,	8.35	23.95
Soda,	34.35	30.63
Chlorine,	5.20	1.81

(*See Trans. of Amer. Assoc.* 1851, pp. 195, 221.)

562. Composition of the Green Cucumber, *(John.)* The peeled fruit (A,) the fresh peel, (B.)

	A.		B.
Sugar and extractive,	1.66	Solid matter, similar to that of the pealed fruit but containing much Lignin,	15
Chlorophylle,	0.04		
Lignin with phosphate of lime,	0.53		
Mucas, with phosphoric acid ammonical salt, malate, phosphate, sulphate, and muriate of potash, phosphate of lime and iron,	0.50	Water,	85
Water,	97.14		

563. The pumpkin is generally grown in connection with corn, occasionally with potatoes; and rarely or never alone. Two or three seeds are planted with the corn in the hill or row, and thinned out to one afterwards, the plants being left from 6 to 8 feet apart. No further care is requisite except to gather and store before frosts occur.

564. The usual yield is probably from 3 to 4 tons per acre; but there are instances on record of 7 tons per acre among corn, and 15 tons per acre among potatoes. (*Patent Office Reports*, 1844, p. 144; 1847, p. 188.)

565. There is great difficulty in preserving this fruit during winter; as, in consequence of the quantity of water it contains, frost readily destroys it; and even without frost, rot will occur wherever the skin is bruised. The best mode is to pack upon a tier of rails laid on the ground, under a warm shed, with straw between each tier of pumpkins; and before severe frost occurs, cover thoroughly in all directions with a heavy covering of straw. This latter must be deferred as long as possible, in order to allow the superfluous moisture to escape.

566. It has been recommended to grow the Vegetable Marrow in the same manner, to feed hogs and other animals. This is a very hardy and productive species, but whether it has any advantages above the pumpkin, in an agricultural point of view, has not been tested. An instance is mentioned where 20 tons had been produced on an acre.

567. For fattening hogs, these fruits are supposed to be more nutritive if boiled. For ruminant animals, living on dry food, they are probably preferable in their natural state. Pumpkins increase the yield and richness, and improve the color of milk.

568. The young plants are apt to be destroyed by the Cutworms, and Cucumber Beetle, (*Galeruca vittata;*) and therefore more seed should be planted than is required. Many remedies have been proposed for the injury caused by this Beetle.

The cheapest and most effective is the dusting the leaves with common plaster; or with boiled plaster (such as is used by masons) mixed with spirits of turpentine, and dried. This application must be repeated after rain until the rough leaf is well grown. Occasionally, this insect, and another much larger species injure the fruit when ripe by burrowing into it to a considerable depth. The only remedy is harvesting as rapidly as possible. In some localities the Cucumber Flea Beetle *(Haltica pubescens.)* is also injurious to the young plants.

569. TOBACCO, *(Nicotiana Tabacum)* belongs to the *Solanaceæ*, or Nightshade family, and is nearly connected with the Jamestown Weed *(Datura Stramonium)* and Henbane *(Hyoscyamus niger,)* well known weeds and medical poisons. One species, Wild Tobacco, *(N. rustica)* is found indigenous to the Northern States. There are several other species, *(N. repanda, Persica, Glutinosa, Macrophilla, &c.)* the first of which forms the best Havanna cigars; and the second, "the delicate and fragrant tobacco of Shiraz;" besides many varieties. It is a native of America; and was found by Columbus to be in common use among the Indians in 1492. It was introduced into France in 1559, and into England in 1586. It is now cultivated in most parts of the world, except Great Britain where its culture is prohibited by law; but the tobacco of Cuba, Virginia, Maryland, Kentucky, and Connecticut is the most celebrated. No plant, perhaps, more readily adapts itself to greater differences in climate, or none, except the grape, changes more in its composition and economical value. At the same time it is remarkable for the injurious and impoverishing effect that it produces upon the soil. The tobacco of Michigan is said, so far, to have proved inferior in flavor and strength; while a valuable article is brought to market from Western Canada.

In three or four years, the tobacco grown in Germany from American seed, acquires an aroma perfectly distinct from that of fine tobacco, and

this it retains pertinaciously. Too rapid and luxuriant growth spoils the flavor of the leaf, which on the contrary is heightened by pruning.

570. The Virginians began to cultivate this plant very early, following the Indian mode. In 1611, it was first grown by the use of the spade, and shortly increased to so great an extent as almost to preclude the sowing of grain. Before the Revolution merchantable tobacco was a legal tender in which taxes and ministers' salaries were paid, and it almost became the currency of the colony. At present the culture in the United States appears to be on the decline. In 1840, the total produce of this country was 219,163,319 lbs; in 1850, 199,752,646 lbs, showing a decrease of 19,410,673 lbs.

The chief tobacco producing States in 1850 were:—

Virginia,	56,803,218 lbs.	North Carolina,	11,984,786 lbs.
Kentucky,	55,501,196 "	Ohio,	10,454,449 "
Maryland,	21,407,497 "	Connecticut,	1,267,624 "
Tennessee,	20.148,932 "	Indiana.	1,044,620 "
Missouri,	17,113,784 "		

No other State gives one million of pounds; Michigan returns only 1,245 lbs.; while Maine, Vermont, Rhode Island, Delaware, and Minnesota produce none.* The principal varieties cultivated in the United States, are the Virginian; Large-leaved; Dwarf; Cuba; Common Green; Summerville; Light Burley, &c.

571. Proximate analysis of the fresh leaves of Tobacco. (*Posselt and Reinmann.* 1827.)

Nicotina,	0.06	Malic acid,	0.51
Nicotianin,	0.01	Lignin and a trace of starch	4.969
Bitter extractive,	2.87	Salts,	0.734
Gum with malate of lime,	1.74	Silica,	0.088
Chlorophylle,	0.267	Water,	88 280
Albumen and gluten,	1.308		

*From 1800 to 1839 the whole quantity of tobacco exported from the United States, annually, was about 82,000 hogsheads. The Western States, during this period, never exported, on an average, over 35,000 hogsheads. In 1840, the West exported 40,000; in 1841, 54,600; in 1842, 68,000; in 1843, 89,800; and in 1844, 81,200 hogsheads. This last was nearly as much as the consumption of Europe then demanded. From 18 000 to 20,000 hogsheads of Virginia tobacco were consumed at home. Above 75,000 hogsheads were supposed to be raised in other countries than the United States.

572. Inorganic analyses of eight specimens of Hungarian tobacco-leaf. *(Will and Fresenius.)*

	Mean of 4 analyses.	Mean of 4 analyses.
Potash,	26.46	12.14
Soda,	0.56	0.07
Lime,	27.87	45.90
Magnesia,	9.72	13.09
Chloride of sodium,	6.91	3.49
Chloride of potassium,	2.21	3.98
Phosphate of iron,	7.00	5.48
Phosphate of lime,	——	1.49
Sulphate of lime,	7.14	6 35
Silica,	12.13	8.01
Per centage of ash,	21.28	23.68

(*See, for particulars, Knapp's Chemical Technology,* Vol. iii, p. 149, *and Johnston's Agricultural Chem. last Ed.*)

Among the constituents of the tobacco leaf, *Nicotine* is the most characteristic. This is a volatile vegetable alkaloid (C_{10} H_{16} N_2) belonging to a class of nitrogenous organic substances which are, for the most part, gifted with a very energetic and remarkable action on the animal system. Pure nicotine is a colorless oily liquid with a slight smell of tobacco, which, when the liquid is heated, or mixed with ammonia, becomes very intense and biting; it has also a sharp irritating taste, a few drops acting as a poison on small animals. This substance, which gives value to tobacco, does not exist in a state of nature, but is a product of fermentation. The *fresh* leaves possess very little or no smell. When they are distilled with water, a weak ammoniacal liquid is obtained, upon which a fatty crystallizable substance swims, which does not contain nitrogen and is quite destitute of smell. But when the same plant, after being dried, is moistened with water, tied together in small bundles, and placed in heaps, a peculiar process of decomposition takes place. Fermentation commences, and is accompanied by the absorption of oxygen, the leaves become warm, and emit the characteristic smell of prepared tobacco. When the fermentation is carefully promoted, this smell increases; and after the fermentation is completed an oily azotised volatile matter, called *nicotine*, is found in the leaves. This substance was not present before the fermentation. The different kinds of tobacco are distinguished by having very different odoriferous substances, which are generated along with nicotine. (*Liebig Ag. Chem.*) This fermentation begins during the harvesting, or even before, but is

stopped by the process of drying. The quantity of nicotine in the *fresh* leaves has been estimated at $\frac{6}{10000}$; in *commercial* leaves at $\frac{52}{10000}$ to $\frac{100}{10000}$. It varies according to the locality in which the plant is grown, rendering it stronger or weaker, as follows :—(*Schlosing.*)

	Per centage in the dry leaves.		Per centage in the dry leaves.
Department Lot, (France,)	7.96	Department Elsas, (France,)	3.12
" Lot-Garonne, "	7.34	Virginia,	6.87
" Nord, "	6.58	Kentucky,	6.09
" Ille Vilaine, "	6.29	Maryland,	2.29
" Channel of Calais, "	4.91	Havanna, less than	2.

Besides Nicotine, tobacco contains albumen, and a gluten-like substance, gum, resin, malic, and citric acid.

It has been discovered by the "Tobacco Administration" in Paris, that the value of tobacco stands in a certain relation to the quantity of potash contained in the ashes. Another striking fact was also disclosed. Certain celebrated kinds of American tobacco were found gradually to yield a smaller quantity of ashes, and their value diminished in the same proportion. (*Liebig Agricul. Chem.*) The large quantity of ammonia, of lime, and the alkalies required by this plant is the cause of its so rapidly impoverishing the soil, while it supplies no material for the production of manure. The mode of cultivation, also, exposing the soil to the evaporating effect of the hot sun undoubtedly adds to the evil. In rich loams, where the solution of the minerals of the soil is rapid, and where 10 to 20 per cent of vegetable matter is incorporated in the earth, tobacco may be obtained for many years, but it is always an exhausting crop. It has been stated, that a crop of tobacco removes, in less than three months, 170 lbs. of mineral matter from one acre of land, without estimating the silica. The important mineral substances presented in Havana tobacco, were in 100 parts ashes:—(*Hertwig, in Liebig's Annalen, April* 1843.)

Salts of Potash, - -	34 15	Salts of Lime, - -	51 38
Magnesia, - -	4.09	Phosphates, -	9.04

"The total quantity of tobacco retained for English consumption in 1848, was nearly 17,000,000 lbs. North America alone produces upwards of 200,000,000. The combustion of this mass of vegetable matter would yield about 340 000,000 lbs. of carbonic acid gas; so that the yearly increase of carbonic acid gas from tobacco smoke alone cannot be less than 1,000,000 lbs; a large contribution to the annual demand for this gas made upon the atmosphere for the vegetation of the world." (*Ellis.*)

573. The manure for this crop should be such as can rapidly and readily supply ammonia; for instance, guano, night-soil,

hog's dung, well rotted sheep and cow stable manure, &c. In Europe, malt-dust, and rape-cake, either powdered or dissolved in urine are highly prized. The manure and urine of horses are objectionable as giving a bad taste to the tobacco. *(Colman's Europ. Agricul. ii.* 548.*)*

All the ingredients necessary to replace the ash of 100 lbs. of tobacco leaves, are present in the following mixture:—*(Johnston.)*

Bone dust, -	15 lbs.	Carbonate of Soda, (dry)	5 lbs.
Sulphuric acid, -	8 "	Carbonate of Magnesia,	25 "
Carbonate of Potash, (dry)	31 "	Carbonate of lime, (chalk)	60 "

The leaf appears to have the power of replacing a deficiency of potash in the soil with lime; while, as was before shown, the soil and climate produce a great difference in the proportion of the inorganic constituents.

574. The best soil for this plant is a light sandy loam; or a light soil rich in organic matter, having a portion of sand mixed with it. Clay soils are not adapted for it. New or fresh land is better than old; and pretty steep hill-sides, if light and rich, are better for the production of fine tobacco, than level land.

575. The following is the mode of culture pursued in Connecticut and New York; and in the West, north of the Ohio river. *(a,)* A "seed-bed" is prepared as early in April as possible, for which the richest and best land, moist but not wet, is chosen. It is manured, dug deeply, pulverized, and rendered fine and smooth; and the seed sown broad-cast, at the rate of one table-spoonful to the square rod, before the earth becomes dry. After this it is raked, but the seed is not buried; it is rolled, or a man treads it in, rendering the surface of the bed as hard as possible. Weeds must be carefully extirpated. When the plants have leaves two or three inches long they are fit for transplanting—about the beginning of June. *(b,)* The field intended to be planted should be well manured, and plowed at least twice; harrowed, and rolled, and left as smooth as possible.

The rows are marked out, 3 feet, or 3 feet 4 inches, according to the variety grown; and on these rows small hills are formed for the reception of the plant, at 2 feet, or 2½ feet apart. To make *fine* tobacco it is important to plant early, so that the leaves may be cured when the weather is warm and dry. If it rains at the time of setting out, advantage is taken to plant as many as possible. If not, about half a pint of water is poured into each hill, and the plants immediately set.* After this, the field is examined several times, and where plants are dead, or injured by the worm, others are set in. *(c,)* As soon as they stand well, they are either carefully hoed and the vacant places filled with new plants, or the cultivator is merely passed between the rows. After this the plants are kept clean with cultivator and hoe, being hoed three or four times without hilling. The plants are frequently and thoroughly examined for the tobacco worms; and they must be destroyed, or the crop will be greatly injured. *(d,)* When in blossom, and before the formation of the seed, the plants are *topped* about 32 inches from the ground, leaving from 16 to 20 leaves on each stalk. If there are late plants, in consequence of re-setting, break them low, and they will grow faster and ripen sooner. All suckers must be broken off. *(e,)* When ripe, the time of cutting—the leaf is spotted, thick, and will crack when pressed between thumb and finger. It may be cut any time in the day after the dew is off; left in the row till wilted; then turned; and if there is a hot sun, it is turned often to prevent burning. After being wilted, it is put into small heaps of 6 or 8 plants, and carted to the sheds for hanging. Here it is hung with cotton twine on poles 12 feet long, and about 20 plants on each side. It must hang until the stem of

*It may be useful to mention that all young plants, either in garden or field, may be transplanted with great certainty of success by forming a deep hole with a round stick an inch in diameter; insert the root in the centre of this hole, holding the plant with the left hand; pour in water till it overflows; and immediately fill it up with fine earth dribbled in with the right hand. Even cucumbers and melons may be safely transplanted by this method.

the leaf is thoroughly cured to the stalk—from 6 to 10 weeks. It is then taken down, in a damp day (to prevent the leaves from crumbling,) and placed in large piles by letting the tops of the plants lap each other, leaving the butts of the plants out. It remains in these heaps from 3 to 10 days, before it is stripped, depending on the state of the weather, but must not be allowed to heat. When stripped, it is made into, or tied in 3 small "hands," the small and broken leaves being kept by themselves. When fit for market, it is collected in large quantities,andslightly pressed in boxes containing about 400 lbs. each.

576. In some places in the South, it is the custom to dry the leaf by fires, a process which requires much care and experience; and a peculiar class of buildings or sheds. The seed-bed is also, at times, burned or charred before the seed is sown; a process which, in certain soils only, enriches the soil by setting free the inorganic nourishment; adds ashes, from the fuel consumed; and destroys the seeds of weeds, but also much of the organic matter of the soil.

577. In Kentucky and Indiana, and some other districts, hogsheads are used for packing. The hogshead should be 4½ feet long, and 3½ broad in the head, with a bulge only sufficient to hold the hoops. Such a cask should hold, without too hard pressing, which is injurious, 1300 or 1400 lbs. of net tobacco. The cask should weigh 150 or 160 lbs. Ash timber is the best for the purpose.

578. The crop varies from 1000 to 2000 lbs. of dry leaf to the acre, according to the variety, closeness of planting, and soil. An average crop of 2700 lbs. has been grown on several acres. In France the crop is stated to be 4000 lbs. (*Colman.*)

579. The following was the cost of cultivating one acre in Massachusetts in 1845:

Interest on land,		$15.00
10 carts of manure, @ $2.50 Carting and spreading,	25.00 5.00 } one half,	15.00
Plowing twice,		3.00
Harrowing and marking,		1.00
Seven thousand tobacco plants,		3.50
Holding and setting,		3.00

Hoeing 4 times, - - - - -	5.00
Securing and killing worms, - - -	2.00
Topping and securing, - - - -	4.00
Cutting and hanging to dry, - - -	4.00
Shipping and packing, - - - -	5.00
Rent of drying shed, - - - -	4.00
Freight, - - - - -	3.00
	$67.50
Produce 2000 lbs. @ 8 cents,	160.00
Net profit,	$92.50

580. The chief disease which affects the tobacco leaf is the "spot" or "firing," believed to be owing to rot. It appears when there is too much rain; and is more liable to occur on sandy soils, than on those that are "stiff, red and thirsty." We suspect that it is owing to too rapid an absorption of some material from the soil, during wet weather; and that it resembles the "curl" of the Peach-tree leaf under similar circumstances. The practical cure is said to be deep plowing between the rows as soon as it appears. A careful analysis of the leaf would probably show a change in the proportion of some inorganic constituents.

581. The only insects usually liable to injure this plant, are a Cut-worm, and the Tobacco-worm; the latter follows this crop wherever it is cultivated. Dr. Harris does appear to mention it. The worms attack the plant twice in a season, first when the latter are one third or one half grown, and again when the tobacco is ready for cutting. The most effectual remedy is gathering them by hand and killing them; but Turkeys are found of great assistance in destroying these insects: they eat, and kill thousands which they do not eat. The first brood may be readily destroyed by Turkeis, but when the second one appears the tobacco is generally so large that Turkies do but little good. *(See Farmer's Library for* 1848, *for a full account of this Insect.)*

582. To save the seed, allow a few of the strongest plants to produce their flowers. Each plant will ripen, in September, as

much seed as may be necessary for stocking half a dozen acres.

(For further information on this extensive subject the reader is referred to the various works on practical agriculture; *the Patent Office Reports,* especially the vols. for 1846, pp. 740–754, and 1849, pp. 318–326, containing a *Prize Essay, by W. W. W. Bowie of Maryland,* and for the manufacture, to *Knapp's Technology,* vol. iii.)

583. THE CASTOR OIL PLANT, PALMA CHRISTI, *(Ricinus communis,)* belongs to the *Euphorbiaceæ*, or Spurge family;—a family which contains the Croton Bean, and many other medical plants.

It is a native of India, but has been known from the earliest antiquity, seeds of it having been found in some Egyptian Sarcophagi, and it was used by the Greeks. It is naturally a perennial, attaining the height of 15 or 20 feet, with a thick stem; but in cold climates it becomes an annual, not more than 3 to 6 feet high. There are many instances of perennial plants becoming annuals by change of climate, as is the case with the common English daisey when transplanted to, or grown from seed in India. There are 5 distinct varieties or species, differing chiefly in the color and pruinous condition of the stem, and the quantity of oil yielded by the seed.

584. This plant is cultivated to some extent in Indiana, Illinois, Georgia, and other States enjoying a like temperature. The only useful part is the seed, or "bean," from which an oil is expressed, to be used in medicine; for the manufacture of hair-oil by barbers; for machinery; and for burning. In its common state, the odor and taste are exceedingly disagreeable, but these can be eradicated by refining. The American oil is of very fine quality. and has a less unpleasant flavor than the East Indian; but it is often objected to by Druggists in consequence of its depositing a solid fat in cold weather. *(Pereira.)*

585. No analysis of any value to the Farmer has been published.

586. A good crop will yield 35 bushels of beans per acre, and the oil will be from 25 to 60 per cent according to the goodness of the seed and manufacture. The cultivation is similar to that

of corn. The beans from which the oil has been expressed are said to form a valuable manure. They appear to contain a large amount of nitrogenous matter; and the stems, roots. &c. can be plowed in again.

587. LIQUORICE, *(Glycyrrhiza glabra.)* This, also, is a medical plant, with a local agricultural importance, and it might be still further profitably introduced into the United States as one of the minor products of the soil. It is a native of, and cultivated in the South of Europe, but prospers in England. Our annual import of it is said to exceed $250,000, and the demand is constantly increasing. The root, (the only useful part,) has recently been employed in France for the manufacture of paper. It was introduced into Georgia and the Carolinas at an early day, but the great attention now paid to Cotton has caused it to be neglected. It is a perennial, with long tap-roots extending very deep into the ground, and creeping to a considerable distance.

588. The soil should be a moist, loose, sandy loam; or diluvial of river-bottoms. If not rich, it must be manured with *well rotted* dung, ashes &c. It should be subsoiled or trenched 3 or 4 feet deep; and if sufficiently rich, thrown into three and a half foot beds, including the alleys, in the centres of which the sets are planted early in March, 18 inches apart. If the ground is not sufficiently rich, trenches must be dug throughout the field, 3½ feet apart, from centre to centre, and 3 or 4 feet deep. When one trench is dug, it must be filled with earth from the next, well incorporated with compost, and alleys made 7 or 8 inches wide, mid-way between the trenches, the earth being spread over them, so as to form raised beds throughout the plantation.

589. The "sets" being procured, and cut into five or six inch pieces, dibble holes along the centres of the beds, 18 inches apart, and 8 inches deep, into which thrust a piece of root, and cover

it up. The after culture, for that season, consists in keeping the beds perfectly free from weeds, by the hoe. In the fall, when the stems are decaying, they are cut down, and a light dressing of rotten manure is spread on the surface. Early the following Spring, dig lightly between the rows, taking care not to injure the roots. During the second and third summers, the only labor is hoeing to kill the weeds.

590. At the end of three years the roots are fit for harvesting; which is done when the stalks are fully decayed. Begin by digging at one end of the rows, and so take up all the roots. When they are collected, the small side shoots are trimmed off, and preserved in dry sand in a cellar for fresh "sets"; and the large roots are prepared for sale. They are offered in three shapes—the entire root—the same dried and ground to powder—and the inspissated juice. The sooner liquorice is sold the heavier it weighs; and the greener it is the more virtue it contains. An acre has sometimes produced 4000 to 5000 lbs. of roots, valued at $400 to $500. *(Jour. of the U. S. Agricul. Socy. July* 1853, *p.* 53.*)*

591. There are various other plants which have been recommended for cultivation in the United States, which have not yet been introduced to any extent, such as (*a*,) *Madia Sativa*, grown in Germany for its oil; (*b*.)*Myagrum Sativa*, Gold of Pleasure, also cultivated in Europe for oil; and in England for Sheep-feed and oil, as it may be pastured early and yield a good crop of seed afterwards. It is perfectly hardy in the neighborhood of Detroit, bearing the coldest weather, and being among the first flowers in Spring to blossom. In the South of Europe it gives two crops in a season. (*See Patent Office Report* 1846, *page* 314; *Thaer's Princ. of Agricul. ii*. 528. (*c*,) The Bene Plant, (*Sesamum Orientale*,) cultivated in South Carolina and Georgia for its oil, which is as good as that of the Olive for table use; andthe leaf is employed as a cure for summer diarrhœa in children. (*d*,) Madder, (*Rubia Tinctorum*,) and (*e*,) Indigo, used in dyeing, the former remaining 2 or 3 years in the ground before harvesting: both of these require a warm climate. (*f*,) Dyer's Weld (*Reseda Luteola*,) grown in Germany as a dye; the cultivation is represented as both easy and profitable. (*g*,) Dyer's Woad, (*Isatis tinc-*

toria,) the seed of which, with that of Weld, has lately been dristributed by the Patent Office. The leaves are the part used. There are others of a similar character; but in general they require too much time and labor to perfect, or the demand is too limited to attract general attention.

(For a full account of the culture of *Madder*, *Woad* and *Weld*, in Flanders, see Colman's *European Agriculture, vol. ii. pp.* 550–552.)

CHAPTER XX.

TEASEL. FLAX. HEMP. BROOM CORN. OZIER WILLOW.

592. TEASEL *(Dipsacus Fullonum,)* is a native of Europe, and is used by the manufacturers of woollen cloth to raise a nap on the surface, by means of the fine and elastic hooks with which the seed pod is armed. There is a native American species *(D. sylvestris,)* devoid of these hooks, and therefore useless.

593. It was not till about 1820 that this plant was introduced into field culture in the United States. It is now grown in parts of New York and New England, in sufficient quantities to supply the demand. The first raised in this country sold for $10 per thousand ; as late as 1835, they were imported at a cost of $4 or $5 per thousand; from 1845 to 1850, they were afforded as low as 75 cents to $1 per thousand. The demand for them necessarily increases with the number of woollen manufactories, and as these are met with in most of our Western States, this plant could probably be grown with sufficient facility and profit, on a limited scale, to make it worth the attention of Western farmers, for home use.

594. Having a tap-root, the teasel requires a deep rich soil. A strong, gravelly loam produces the best and most serviceable heads; and sward-land plowed deep, and well turned under in April is preferred. After plowing, the soil is pulverized and made smooth and even. The land is marked out in rows 3 or 3½ feet apart, or a drill is used, and the seed sown at the rate of 6 quarts to the acre, and lightly covered. This should be done early in May. In about a month, the field is thoroughly weeded with the hoe and fingers, and the plants thinned out to a distance of from 4 to 6 inches. After this, a cultivator is used

between the rows, and the earth drawn lightly around the plants with a hoe, thinning them to a distance of 6 to 8 inches. During the rest of the season, the weeds must be kept down, and the earth preserved mellow by the cultivator and hoe. Early the next spring the cultivator is again used, and earth drawn around the roots with the hoe. In July, the blossoms will appear; and about the first of August the earliest are sufficiently ripe for cutting. This is done as soon as the blossom is entirely off the "bur," and before the seed is fully matured. It is necessary to go through the field two or three times to collect them all at the proper age, to prevent any being injured by remaining on the stem while others are being matured. Cutting is performed with a large knife, held by the workman in one hand, while he seizes the teasel with the other, leaving from 3 to 6 inches of stalk, and throwing it into a basket. An experienced workman will cut from 20,000 to 25,000 in a day, if the crop is a good one. When taken from the field, they are carefully spread, 6 inches deep, on *open* floors, in an airy place, under cover. If the weather is damp, they must be frequently turned. When sufficiently dry, which is known by the seed seperating freely in moving, they are stored away, or packed in boxes for market. The yield is from 50,000 to 200,000 per acre, worth from 75 cents to $2 per thousand. In Europe, they are sorted according to quality, each quality being known by a peculiar name, and they are bound up in a curious manner.

595. The only insect injurious to this plant is "the common white grub" which feeds on the young roots; in some instances to such an extent as to destroy a whole crop. The winter, also, occasionally makes great destruction; the plants being partially or entirely killed [in Oneida county, N. Y.,] by an open winter, accompanied by severe frost. Late frosts in Spring are likewise injurious. A sort of "rust" is also destructive, caused by a long continuance of warm, wet weather, after the flower bud is fully formed. (*Patent Office Report*, 1850, p. 315.)

596. The use of teasels has been, to a considerable extent, superseded in the United States, within a few years, by the introduction of machinery to produce the same effect. *(Allen.)*

597. To procure seed, it is only necessary to leave a few of the strongest plants, till they are quite ripe, dry them well, and thrash with a flail.

598. FLAX *(Linum usitatissimum)* is a native of Europe but has long been cultivated in this country. There are two indigenous species in the Northern United States, *(L. Virginianum,* and *rigidum,)* of no economical value. Two species or varieties are cultivated, the common, and one with a yellowish seed, lately introduced into Ohio, which is said to yield a larger crop, and to be in many respects superior. We have seen the seed, but not the plant.

599. The census returns of flax are stated to be incorrect, and not to be depended on; but there is reason to believe that its cultivation is rather decreasing than otherwise, in consequence of the difficulty of preparing the fibre for market; and the seed alone not proving sufficiently renumerative.

600. Inorganic analysis of the entire plant of the flax grown in Ireland. *(Sir R. Kane.)*

Potash,	11.78
Soda,	11 82
Lime,	14.85
Magnesia,	9.38
Alumina and oxide of iron,	7.32
Phosphoric acid,	13 05
Sulphuric acid,	3.19
Chlorine,	2 90
Silica,	25.71
Per centage of ash, dry,	5 00

601. Inorganic analysis of Linseed. *(Johnston.)*

		Riga.	Dutch.
Potash,	25.85	17.59	30.01
Soda,	0.71	6.92	1.88
Lime,	25.27	8.46	8.12

		Riga.	Dutch.
Magnesia,	0.22	14.83	14.52
Oxide of iron,	3.67	1.25	0.68
Phosphoric acid,	40.11	36.42	37.64
Sulphuric acid,		2.47	2.16
Sulphate of lime,	1.70		
Chlorine,		0.17	0.29
Chloride of sodium,	1.55		
Silica,	0.92	10.58	5.60
Percentage of ash,	4.63		

602. Inorganic analysis of English (A;) and American (B,) Linseed cake. *(Johnston.)*

	A.	B.
Alkaline salts,	32.72	38.28
Phosphates of lime and magnesia,	49.44	56.40
Lime,	5.06	1.25
Magnesia,	1.57	trace.
Silica and sand,	11.21	4.07
Percentage of ash,	7.3	6.04

The alkaline phosphates are included among the alkaline salts.

603. When the Flax plant is steeped in the ordinary way of preparing it for the flax-mill, much of the saline matter it contains is extracted by the water. This water, when evaporated (in Ireland) left a dry solid extract, which being burned gave 42 per cent of ash, of which the composition was: *(Sir R. Kane.)*

Chloride of Potassium,	9.05
Sulphate of potash,	10.48
Carbonate of potash,	9.05
Carbonate of soda,	31.43
Phosphate of iron and alumina,	7.62
Phosphate of lime,	5.00
Carbonate of magnesia,	4.76
Carbonate of lime,	9.52
Silica,	13.09

The saline matter is not by any means all removed by steeping. Both the outside portion taken off at the flax-mill, and the pure fibre leave when burned a considerable proportion of ash.

604. Ultimate analysis of Linseed. *(Thompson.)*

	Fresh.	Dried at 212° F.
Carbon,	42.51	49.55
Hydrogen,	6.22	7 26
Nitrogen,	3.78	4.41
Oxygen,	26.35	30.68
Ash,	6.94	8.10
Water,	14.20	

605. We are unable to meet with a perfect organic analysis of either the plant or seed, but the following results of 44 analyses by Way, Nesbit, and Lawes, of English, American and Dutch Linseed, will give an idea of the composition:

Water,	7.6	to	12.4	per cent.
Organic matter,	81.0	to	84.1	"
Ash,	5.44	to	11.40	"
Nitrogen,	4.57	to	5.28	"
Albumen, gluten, and casein,	22.2			"
Fat or oil,	9.1	to	13.5	"
Gum, dextrine, &c.,	36.3	to	39.1	"
Fibre and Husk,	9.5	to	12.7	"

606. The following recipes are given as special manures to return to the soil what is carried of by the seed (A;) and stem (B,) of Flax. *(Johnston.)*

	A.	B.
Bone dust,	144 lbs.	50 lbs.
Sulphuric acid,	72 "	25 "
Carbonate of potash (dry,)	36 "	17 "
Carbonate of soda, (dry,)	6 "	20 "
Carbonate of magnesia,	22 "	21 "
	280 lbs.	133 lbs.

Linseed leaves (on an average) 6 1-2 per cent of ash, so that for every 100 lbs. of linseed harvested, 13 lbs. of the above mixture require to be added to the land. The dry stem leaves 5 per cent of ash; every ton therefore carries off the land 112 lbs. of inorganic matter, to replace which 150 lbs., of the above mixture must be added. If this be carefully done, and if the fermented scutchings be returned to the land, the culture of flax will cease to be exhausting. The flax-fibre is almost pure *Liguin.*

Flax is cultivated in the United States for two purposes, for the fibre for weaving, and for the oil. The States which chiefly grow it are Kentucky, New York, Ohio, Pennsylvania, Virginia, Indiana, Missouri, &c. Nearly every State returns, in the census, more or less. Were an easy and cheap mode of preparing the fibre introduced, as there is every probability of there being, this crop would become both profitable and popular; as the supply, both here and in Europe, is inferior to the demand. The oil, the cake, and the seed are exported to Great Britain to some extent. The fibre is believed to be principally consumed at home. This is one of the farm products which demand the assistance of the manufacturer along side of the farmer to render it truly valuable; or the farmer has to relinquish his legitimate business, as a producer of raw material, and prepare the article for market, in its first stages of utility. Machines have lately been invented in Europe which entirely relieve the grower of the plant of the unpleasant labor of steeping, scutching, &c.; and by one of these new processes, the liquor, in which the flax is prepared, is employed, with success, for fattening hogs, and cattle.* (*Journal of Highl. and Agricul. Soc'y of Scotland*, No. 42, 1853.

In this place, we shall omit any mention of the European mode of cultivating this crop, as being much too laborious and expensive for the United States, and merely give an outline of the usual way of growing it here; nor shall we describe the steeping, &c., as these after-processes demand a practical skill and experince which cannot be taught by writing.

607. *(a,)* The character of the soil depends upon the purpose for which the flax is required: if for seed it can scarcely be too rich; if for fibre, it must not be such as will cause rank growth. The general principles are, to employ *clean* land, free

*In the Weekly N. Y. Tribune of January 14, 1854, appears an advertisement of "Flax and Hemp Machinery" for pulling flax, and breaking and dressing flax and hemp. It is said to require but few hands and little power to operate it, leaving the Flax and Hemp line in better condition than has been attained by machinery heretofore in any country.

from weeds, as the flax-plant is delicate and easily smothered; land containing much organic matter, as rich prairie; and either naturally, or artificially abounding in lime. Lime, ashes, and well rotten manure may always be used to advantage. *(b,)* Plow *deep*, as soon as the crop is off the field in the fall. Where frosts are severe, it is advantageous to throw the land up in ridges, so as to allow entire disintegration. In the spring, plow again, four or five inches deep; or if the soil is tenacious and weedy, plow twice in the spring. The object is to render the land really friable, and exterminate the weeds as thoroughly as possible; and this may be done in any manner that the farmer finds the most expedient. Harrow lightly. *(c,)* Sow broadcast, 2½ to 3 bushels per acre of seed, and harrow thoroughly both ways. With *thick* sowing the fibre is of greater length and fineness than in thin sowing; in the first case, the stem grows tall and straight producing little seed; in the latter the plant grows coarse, producing much seed, and a very inferior quality of fibre. As *thin* and *thick* sowing are merely comparative terms, experiments should be tried by each farmer in order to ascertain the best quantity on his own land. The seed should be deposited about an inch deep. Finish by rolling, which is considered essential. *(d,)* The field is kept clean of weeds by the close thick growth of the plant, or by hand-weeding. *(e,)* If intended for the fibre, much experience is required in harvesting; as the marketable value of the straw depends altogether on the manner in which it is saved. The degree of ripeness is of peculiar importance. In Ireland, the best time is decided to be when the seeds are begining to change from a green to a pale brown, the stalks for two-thirds of their height being yellow. In Europe, it is pulled by hand. In America the crop is often cradled, the scythe being from 18 to 22 inches long. In this case it is recommended to cut as soon as the blossoms begin to fall. If intended only for seed, leave till the *bolls* are generally turned yellow; and treat like wheat. The

after-process, when fibre is wanted, must be learnt by experience.

608. The crop of fibre in the United States is said to average 200 lbs. per acre, if the plant is allowed to seed; but 400 lbs. if it is harvested when in blossom. The quantity of seed is from 8 to 15 bushels per acre; and about 2 gallons of oil are expressed from one bushel. But we find premium crops in New York of 28½, and 20 bushels of clean seed, and 567 lbs. of dressed flax per acre.

609. Cost of cultivating 1.54—100 acres of Flax in Rensselaer county, N. Y., in 1851. The soil was a heavy loam, on upland, the crop next preceding was oats; and the crop preceding that was corn; on land many years in pasture. No manure was used.

1½ days plowing,	$3.00
½ " harrowing and sowing,	1.00
6 " pulling Flax at one dollar per day,	600
2 " thrashing and cleaning seed at one dollar per day,	2.00
1 day spreading and taking up,	1.00
1 " drawing in, and drawing to mill,	2.00
1½ bushels seed at $1.50,	2.25
Paid for dressing and marking flax,	15.96
Interest on land,	10.50
	43.71

CROP.

By 23 bushels clean seed at $1.50,	$35.50	
By 798 lbs. dressed flax at 10 cents,	79.80	115.30
Net profit,		71.59

(See, also, another account in New York Transactions of Agricultural Society, vol. v, p. 338.)

610. An interesting account is given, in 1846, of the growing of Barley and Flax together, in the town of Earlville, N. Y. An acre of land was prepared for barley; after sowing two bushels of this, one bushel of flax-seed was also sown, and the whole harvested together. They were harvested in the usual manner, threshed with a machine, and cleaned;—it is supposed that the seeds were separated by the different sized screens in the fanning mill.—The sale of the crop was:—

30 bushels of barley at 50 cents,	$15 00
15 " flax-seed at $1,	15 00
	$30 00

It was believed that the barley crop was as good as if no flax had been sown; neighboring fields of barley alone giving the same yield of 30 bushels. *(Patent Office Reports* 1846, *p.* 728.*)*

611. Linseed oil, being essential for painting, is in constantly increasing demand. The *Cake* is greatly depended on in Great Britain for fattening stock, and adding to the richness of manure heaps. It is quoted at wholesale prices in New York at $28 to $35, and in London at $45 to 50 per ton. The best quality of the fibre in Ireland is worth from $250 to $300 per ton.

Thompson, in his experiments on cows, found that Linseed-meal produced less milk and butter than Bean-meal. In feeding, too large quantities of linseed must not be given. About 2 lbs. of meal, boiled for 3 hours in 3½ gallons of water, is a sufficient daily allowance, with other food, for an animal weighing 800 lbs. The refuse of the pods is valuable as feed.

612. In large sections of the West, it were of much importance to Agriculturists to influence the establishment of Mills for the preparation of fibre, and for oil-making. The two should always go together.

Two patents for the preparation of the fibre are now used in Europe, and are represented as working economically, and requiring only a small capital. They are Schenk's and Watt's Patents, an account of which will be found in the *Journal and Trans. of the Highland and Agricul. Socy. of Scotland No.* 42, *p.* 116. The *Royal Flax Society* have published much of importance on this subject. Not only is the farmer interested in the direct profit of the crop, but also in the fattening and manure-forming refuse; and as the business of preparing cattle in the West, for the Eastern market increases, flax will become essentially more important to us. But above all, it brings the manufacturer in direct contact with the farmer; and forms a market for his produce at his very door. It is not usually very advisable for the farmer to connect himself with manufacturing processes, but this is an exception; and there are thousands of acres devoted to corn and pork-making, in consequence of the difficulty of reaching a market for coarse grains, where flax culture, with appropriate mills controlled by a company of farmers, would be found exceedingly profitable.

Imports of Linseed into the United States for the past five years:—

1849	bags 85,970	1852	bags 191.979
1850	" 108,401	1853	" 228,737
1852	" 192,090		

Imports and exports of Linseed oil:—

Imports.		Exports.	
1852	bbls. 11,364	1852	bbls. 12,427
1853	" 17,056	1853	" 20,536

(*N. Y. Weekly Tribune, Jan.* 14, 1854.)

Oil meal is quoted in New York at $1.44 to $1.50 per 100 lbs.

613. HEMP, (*Cannabis Sativa,*) is a well known plant cultivated, like the last, for the sake of its fibre, employed in the making of ropes, and coarse fabrics. It is probably a native of India, but it is now extensively cultivated in Russia, as well as in the United States, in Germany, and in other parts of Europe, in Arabia, Africa, &c. It is of the same family as the *Hop* and *Nettle*, the fibres of both of which genera have been used for the same purpose. According to Prof. Gray, Hemp has become naturalized as a wild plant in this country.

The Indian Hemp (*C. Indica,*) (which is the same species (*Pereira,*) as the above,) is well known as affording a resinous exudation, which is used in various forms, to produce a species of intoxication, among a large portion of the human race. In hot climates, the fibre degenerates in quality, while the narcotic ingredients increase in quantity and in apparent strength. "This is another of the many interesting facts now known, which show the influence of climate in modifying the chemical changes that take place in the interior of plants, and the nature and proportions of the several substances which are produced by these changes." (*Johnston in Blackwood's Magazine, Vol. xxxvii. No.* 5, *p.* 617.) This plant is employed to produce a narcotic effect by probably not less than two or three hundred millions of the human race in Asia, Africa, and South America.

614. In the United States, the growing of Hemp is chiefly confined to Kentucky and Missouri; ten other States producing trifling quantities only. In 1850 this plant was not cultivated in Michigan. It is supposed to be decreasing in the annual product.

615. Proximate analysis of Hempseed. *(Bucholz.)*

Oil	19.1	Mucilage	9.0
Husk &c.	38.3	Soluble albumen (casein?)	24.7
Woody fibre and Starch,	5.0	Fatty matter,	1.6
Sugar &c	1.6	Loss	0.7

616. Inorganic analysis of Hemp-seed (A,) *(Johnston.)* and the Straw (B,) *(Kane.)*

	A	B
Potash,	21.67	10.99
Soda,	0.66	1.06
Lime,	26.63	61.75
Magnesia,	1.00	7.16
Oxide of iron,	0.77	0.54
Phosphoric acid,	34 96	4.73
Sulphate of lime,	0.18	——
Sulphuric acid,	——	1.61
Chlorine,	——	5.54
Chloride of sodium,	0.09	——
Silica,	14.04	9.92
Percentage of ash,	2.50	4.54

617. Analysis of the Scutchings of American Hemp. *(Johnston.)*

Alkaline salts, chiefly common salt and sulphate of soda,	3.32
Phosphates of lime and magnesia, and a little phosphate of lime,	19.15
Sulphate of lime, (plaster,)	3.26
Carbonate of lime,	26.45
Carbonate of magnesia,	2.80
Insoluble siliceous matter,	45.02
Per centage of ash in dry fibre,	14.43

618. In Commerce, Russian Hemp bears the highest value, being quoted in the New York Price currents at $265 to $300 per ton, while the best American only brings $180 to $220 per ton. The difference appears to be in the mode of preparation, Russian Hemp not being carried to the fermenting point in rotting; while in the American, incipient decay has already set in. In the latter country, two processes are employed,—"water-rotting," and "dew-rotting." In the American federal and mercantile navies Russian hemp is cheifly employed for cordage. "Russian hemp, when kept moist and warm, will lose its strength in about three weeks;—the American water-rotted in two weeks; and the dew-rotted in from five to ten days." (*Crook & Co.,*

Maysville, Ky. 1848.) The value of American hemp, however, is said to be rapidly increasing, owing to greater care and experience in preparing it for market. In 1845, the Navy Department decided that "American water-rotted hemp when made into cordage *without* the application of tar proved to be greater in strenth than Russian; and the application of tar proved to depreciate its strength to that of Russian." Large quantities of Western hemp are annually manufactured into cotton-bagging and bale rope. In 1845 the quantity so consumed was estimated at 40,000,000 lbs., sufficient to cover, 2,600,000 bales of cotton.

619. The best land for hemp is that which has been timbered with black walnut, buckeye, hackberry, and white oak; or rich bottom lands. If sward land, plow in the fall, and again in the spring; if fallow, one deep plowing, well harrowed, in the spring is sufficient. In Missouri, 1½ bushels of seed are sown broadcast per acre, from the 1st of April to the 10th of May. When the blossoms begin to fall, (from the middle of July to the 1st of August,) the hemp is cut. If left later, the quality is injured. An impliment similar to the point of an ordinary scythe, is used for harvesting. The plant is cut as close to the ground as possible, and the tops are lopped off as far as the seed ends, and the stalks are either thrown into the shade, or kiln-dried. While cutting, the stalks are assorted according to size; and bound up into bundles, 6 or 8 inches in diameter at the the butts, with two bands. A stick an inch in thickness, is placed in the center of each bundle, to facilitate handling. The bundles are then placed in properly prepared pools. or cisterns for rotting. Hemp, less than five feet in length, is reserved for dew-rotting. After a proper period, the bundles are withdrawn from the water, dried and stacked. After this, the mechanical operations of breaking, &c, succeed. (For a full account of this subject, in all its aspects, see *Pat. Off. Rep.* 1845 and 1846, and the other volumes.)

620. A species of wild hemp, resembling the Manilla, is said to be found in St. Louis county, Missouri; but it does not appear to be described by the Botanists. (*Pat. Off. Rep.* 1846, *p.* 261.) A "Centen-

nial Hemp'' cultivated in China is recommended as adapted to this country.

621. Cost of cultivating 1 acre of Hemp, in Missouri, 1849. (*Patent Office Report*, 1849, *p*. 328.)

Rent of land,	$2.00
1½ bushel of Seed,	0.94
Seeding,	3.00
Cutting,	3.00
Shocking,	0.50
Spreading,	0.50
Taking up after rotting,	0.50
Breaking 800 lbs.	8.00
Hauling to river,	2.00
	$20.44
800 lbs. @ $5 per cwt.	40
Net profit,	$19.56

After this profit to the farmer, it falls into the hands of the merchant or buyer, who, after paying expenses to the St. Louis market realizes as follows:

Cost of 1 ton on bank of river,	$100.00
Baling for shipment'	3.00
Storage,	2.00
Freight to St. Louis,	8.00
Insurance,	1.80
Commission for selling,	3.00
Weighing,	0.40
Drayage and storage 1 month,	1.00
	$119.20
Market value,	125.00
Net profit to merchant.	$5.80

622. Broom Corn (*Sorghum saccharatum,*) is cultivated solely for the purpose that its name indicates. It is said to be a native of India; and that its introduction into the United States was owing to Franklin, who, finding a seed upon an imported whisk, planted it, and thus disseminated the plant.

623. It is grown on a large scale on rich bottom lands in New York and Ohio, and to a more limited extent in nearly all the States. It prospers best on soil abounding in organic matter, damp but not wet. Heavy clays are improper for it. The ground is plowed in the fall, and again in the spring; well-har-

rowed; and the seed sown by a drill, in rows 3½ feet apart, as early as the climate will permit. As soon as it is above ground it is hoed, and soon after thinned, leaving the stalks 2 or 3 inches apart. It is only hoed in the rows to remove the weeds near the plants; the harrow and cultivator are then run through to keep down the weeds, and a small double mould-board plow is likewise used between the rows. It is not left to ripen but cut green. Some persons lop the tops early, and let them hang down to straighten: others leave it till nearly ready to cut. In this case, one set of hands goes forward, and lops or bends the tops on one side, and another follows and cuts them off when bent; a third gathers them into carts or wagons. At the Factory, they are sorted over. and put in bunches, each bunch of brush of equal length. The seed is then taken off by appropriate machinery, worked either by hand or horse-power. The brush is then spread thin to dry on racks, in buildings. In about a week it can be packed away. The brooms are made in winter, at about the rate of 75 dozen per acre. The stalks are left on the ground to be plowed in for manure. The seed is used for feeding stock. *(Albany Cultivator.)* The average yield in New York is 600 lbs. per acre, at a cost of cultivating and securing the crop of $10 or $12. *(N. Y. Trans.* 1849, *p.* 54.*)*

624. Cost of a raising a crop of Broom-corn in Oswego County N. Y., 1846. (*Trans. N. Y. Agricul Socy. Vol. v, p.* 340.) The soil was a rich black loam; the previous crop Indian Corn. The field low and wet with blind ditches. The area is not mentioned.

25 loads of manure,	$3.13
Hauling and spreading same,	3.13
Plowing 1 day, (with horses)	1.00
Dragging ½ day,	0.50
Marking out ground for planting, 3 X 1½ feet,	0.50
8 quarts of seed	0.13
Planting 5 days, at 50 cents,	2.50
Dragging between rows ½ day,	0.50
Hoeing and thinning, 8 to 10 stalks in a hill, 6 days,	3.00
Dragging,	0.25
Hoeing 4 days,	2.00
Tabling the corn, 5½ days,	2.75

Binding and hauling in,			$0.75
Scraping of the seed by machinery,			3.00
Cleaning up seed,			0.50
Interest on land,			3.50
			$29.86
Crop:—1155 lbs. brush a$4.50,		$51.97	
81 " Seed at 18 cents		15.19	
Manure for next crop,		3.14	
			$70.29
Net profit,			$40.40

It will be observed that the wages and cost of horse labor are charged much lower than the present rates.

625. When cultivated on a large scale, with appropriate buildings and machinery for the manufacture of the brooms, the profit is said to be much greater, than when the operations are performed on a small scale. At present, much of the expense incurred in the above account would be saved by the use of improved implements, and with better management. The goodness and elasticity of the brush appear to depend partly on harvesting at the right moment, and partly on the soil and climate. It is said that some soils invariably produce brush of a brittle character. The seeds, for feeding purposes, are estimated as equal to oats, but we are unable to find an organic analysis of them. (*See Pat. Office Report* 1849, *p.* 462.)

626. Inorganic analysis of the ripe Broom-corn brush with the seeds (A,); and the quantity of such matter removed from the soil in a ton of Brush and Seeds, (B). (*Salisbury.*)

	A	B
Silex	32.50	11.960 lbs.
Earthy phosphates,	36.15	13.303 "
Lime,	0.40	0.147 "
Magnesia,	0.10	0.036 "
Potash,	27.32	10.053 "
Soda,	2.37	0.870 "
Chlorine,	2.50	0.846 "
Sulphuric acid,	undetermined	

Composition of the ash of Broom-corn seed. (*Salisbury.*)

Carbonic acid,	not determined.
Silicic acid,	41.975
Sulphuric acid,	not determined.
Phosphoric acid,	28.760
Phosphate of peroxide of iron,	0.525

Lime,	0.845
Magnesia,	3.010
Potash,	3.920
Soda,	7.247
Chlorine,	0.245
Organic acids,	4.200

—(*See Pat. Off. Rep.* 1849, *p.* 473.)

627. Ozier Willow *(Salix.)* This plant is used for the manufacture of baskets, and other willow-ware. The cultivation of it is only commencing among us. Hitherto, some of the wild species, of which there are 22 in the Northern States, have been used for coarse work; and the imports from Europe are stated at $5,000,000 annnally; each ton costing from $100 to $250. If attention were turned to this crop, there is no reason in either the mode of cultivation, in the climate, or appropriate soils, why willows might not become a very profitable product among us. At present, they are grown for market by a few individuals only, in New York, Mississippi, &c. John Reed, of Staten Island, N. Y. is said to have been the first person in America who systematically cultivated the ozier.

628. The species and varieties, useful for this purpose, are very numerous. Dr. C. W. Grant, of Newburgh, N. Y., has in his possession (1854) nearly 100 varieties, more than 70 of which are from England. Several, which are esteemed in that country, have failed with us, probably from their leaves being too delicate to withstand the scorching of the summer sun.

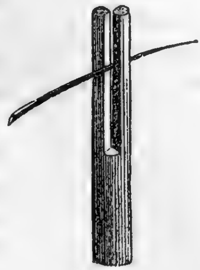
The following species are thus characterized by Dr. Grant. (*a*) Black ozier, (*Salix nigricans,*) brittle, worthless, and not a vigorous grower. (*b*) Round leaved Willow, (*S. Caprea,*) Color dark, quality indifferent, tolerates more water than any tolerably good ozier. (*c*) *S. Viminalis,* in England, the most vigorous growing and generally cultivated; (*d*) and a sub-variety called *Long-skin,* both utterly unsuited to the climate of New York. (*e*) Yellow Willow, (*S. vitellina,*) and (*f*) Huntingdon or White Willow (*S. alba,*) both moderately good; the first as oziers, the second for hoops; and greatly admired as ornamental trees. The following have been found the most valuable, as oziers, in New York. (*g*)

Long-leaved Triandrous Willow, (*S. Triandra,*) very vigorous and productive, excellent for basket work, and especially for "split work." (*h*) *S. Forbyana,* emphatically excellent in all respects. (*i*) Purple Willow (*S. purpurea,*) "If there were but one ozier in existence, this would supply more of the wants of willow-workers than any other *one.*" It is so intensely bitter that neither animals nor insects will touch it. In the West, a decoction of the bark would be valuable in place of Quinine. It is also well adapted for bands and withes for nurserymen. (*j*) A new species from the county of Suffolk, England; it grows with astonishing vigor and is in every respect valuable. (For particulars, see *Farmer's Companion and Horticultural Gazette,* Vol. iii, p. 13.)

629. Willows will grow in a great variety of soils, especially if moist, but not profitably in any greatly unsuited to their habits. Drained swamps, when brought into tillage, afford fine sites for willow plantations, or "halts." Deep, rich intervale, if with a little inclination the better, having a retentive subsoil, with a warm exposure, and some protection from wind, would leave nothing to be desired. A deep rich bottom of sandy loam, that is occasionally overflowed, such as would yield excellent potatoes, but subject to June freshets,—not so much elevated above the summer level of the stream, that by penetrating to the depth of 3 feet, the roots would find moisture,—would have no superior. Any amount of overflowing, not in the growing season, would do no damage, but increase the fertility. Richness of soil is important, great depth indispensable, and easy culture desirable and profitable.

630. Having sufficiently drained, plow deeply, or dig and trench thoroughly, and prepare the field as if for corn. Then insert the cuttings, (which should be two feet long,) perpendicularly and firmly in the soil, leaving only 2 inches above the surface. Plant in rows 3 or 4 feet apart, and one foot between the plants. Keep clean from weeds, at least for the two first years, with the hoe or cultivator. At the end of the second year, the oziers will be ready to harvest. There is a difference of opinion as to the proper season, some recommending the fall, or winter after the stopping of the circulation of the sap;

others, the spring, when the sap starts freely and the buds begin to swell. If cut in winter, the oziers are tied in bundles, and stood up in cold water till spring. Every shoot must be cleared from the stool; leaving, however, about two inches in length for the young shoots to spring from. The oziers are then pealed by a very simple implement. *(See figure.)* It is merely a round stick of hard wood, about an inch thick and a foot long, quartered about half the length of the stick, and the two opposite quarters cut off, so that it will leave a sharp edge on both the remaining two. This tool is taken in the right hand, and the willow inserted in the slit with the left one, and pulled through, the bark coming off. Sometimes, a piece of split iron with half rounded edges on the inside, set in a bench, is used for the purpose. With this a man and three or four children ought to peel 400 lbs. a day. As fast as a little bundle is stripped they are cured by laying them in the sun till they are perfectly dried; and then tied in bundles three feet round the butt; being stowed away in a dry place free from dust. They are sold by weight.



631. In Mississippi the "Italian ozier" is cultivated; it grows on the uplands when well manured, to the height of 8 or 10 feet in a season, clear shoots. Peeled shoots sell in Natchez and New Orleans, for 8 and 10 cents per pound; and cut green, with the leaves stripped, only, in September, for 2 cents per pound. The demand in New Orleans is greater than the supply. *(T. Affleck in N. Y. Agricultor*, Jan., 1853.)

632. We have no data from which we can ascertain the yield per acre, or the profits, but the latter are said to be very large when once the "halt" is fully established. It is to be hoped that our swamp lands in the west will soon be turned to this use; as not only will the country become more healthy, but

thousands of acres can be rendered profitable to the community while at present they are valueless. It is rather a reflection upon us that we are obliged to import such an article as willow sticks; and so rapidly does the demand increase that it must be long before the market can be overstocked.

In John Reed's case we are told that he received more profit from a few acres of willow than from the whole upland portion of his farm. Medicinally, *Salicin*, used, and perhaps, frequently sold as *Quinine*, is prepared from willow bark. This, also, affords much *Tannin*, the cause of its astringency.

CHAPTER XXI.

FRUIT TREES AND VEGETABLES.

633. To enter fully into a detail of orchard and garden plants would too greatly enlarge this volume; but the following notes and analyses are given, the latter not being easily met with, and as being both of interest and practical value to the cultivator. The teacher will experience no difficulty in procuring such practical works in this department as will suffice for his purpose; and more persons appear to be familiar with fruits and esculent vegetables than with agricultural.

634. THE APPLE (*Pyrus Malus*,) (*a*,) a native of Europe, greatly changed by cultivation (*b*,) varieties very numerous, as sour, sweet, summer, autumn, winter, (*c*,) propogated by seeds—grafts—budding—(cuttings) (*d*,) American varieties superior: quality, and value depend on soil and climate (*e*,) cultivation, pruning, gathering, packing, and preserving during winter (*f*,) dried, a considerable article of commerce; machines for the purpose, various, (*g*,) profitable as food for stock, especially the sweet varieties; for hogs better cooked; sour apples said to dry up milch cows, (*h*,) cider making; peculiar varieties for the purpose; process and implements; fermentation, spiritous, acetic; mustard seed delays the latter; when bottled, contains free carbonic acid gas; the use of a raisin in each bottle in assisting to form this gas, (*i*,) manures, bones,—sulphuric acid—ashes—plaster—salt—lime—ammonia—wheat bran. (*j*,) Insects and diseases, (*k*,) the ash of fruit small, in quantity.

635. Analysis of the Pulp (A;) and Skin (B,) of the Swaar apple. (*Salisbury.*)

	A.	B.
Percentage of water,	84.75	61.20
" " dry matter,	15.25	38.80
" " ash.	0.26	0.72
Ash, calculated on dry matter,	1.705	1.856

636. Percentage of water and dry matter in the Tolman Sweeting (B;) Roxbury Russet (C;) Kilham Hill (D;) English Russet (E;) Rhode Island Greening (F.)

	B.	C.	D.	E.	F.
Percentage of water, - -	81.52	81.35	86.31	79.21	82.85
" of dry matter,	18.48	18.65	13.69	20.79	17.15
Mean of the six analyses, per centage of water, - -					82.664

637. Inorganic analysis of the above, excepting the Tolman's Sweeting; and including the Swaar (A;) without carbonic acid:

	A.	C.	D.	E.	F.
Silica, - -	1.750	2.278	1.693	1.051	1.412
Phosphate of iron, -	2.227	1.564	1.838	1.062	1.277
Phosphoric acid, -	14.083	15.057	13.922	11.110	11.664
Lime, - -	4.956	4.857	2.999	3.263	4.421
Magnesia, -	1.786	1.903	1.379	1.068	2.211
Potash, - -	42.016	34.958	35.821	38.323	38.440
Soda, -	19 296	25.173	25.826	30.408	22.781
Chlorine, - -	2.092	2.300	2 334	1.848	2.272
Sulphuric acid, -	6.656	6.889	7.898	6.684	8.019
Organic matter, -	5.139	5.021	6.290	5.187	7.503

1000 lbs. of fresh apples contain about 827 lbs. water ; 170.4 lbs. organic matter ; and 2.6 lbs. of ash. 1000 lbs. of *dry* apples contain 17 to 18 lbs. of ash.

638. Proximate organic analysis of 1000 parts of fresh Tolman's Sweeting; (B) Rhode Island Greening; (F,) and Mean of the analyses of the six foregoing varieties (G.)

	B.	F.	G.
Cellular fibre, - -	33.90	33.58	32.03
Glutenous matter with a little wax and fat,	3.52	1.32	1.94
Dextrine, - - -	28.96	32.07	31.44
Sugar and extract, - -	99.C5	76.37	83.25
Malic acid, - - -	2.50	3.04	3.17
Albumen, - - -	8.97	16.37	13.79
Casein, - -	0.89	1.89	1.64
Dry matter, - - -	177.79	164.64	167.26
Water, - -	815.20	828.46	826.64
Loss, - - -	7.01	6.90	6.10

Besides the above, apples contain a little tannic and gallic acids, especially the Russets. The Tolman Sweeting showed a trace of starch. A small quantity of white wax, and a respectable percentage of gluten also exist. These analyses were made in the month of March.

639. Comparison of the apple (A) with the ripe peach (B,) pear (C,) cherry (D,) and potato (E.)

	A.	B.	C.	D.	E.
Chlorophyl, &c., -		1.10	0.08		
Sugar, -	8.3	16.48	6.45	18.12	0.25
Dextrine, - -	3.1	5.12	3.17	3.23	
Fibre, -	3 2	1.86	3.80	1.12	5.8
Albumen, - -	1.4	0.17	0.08	0.57	
Malic acid, -	0.3	1.80	0.11	2.01	
Citric acid, - -					trace.
Lime, -	4.19	trace	0.03	0.01	
Water, - -	82.66	74.87	86.28	74 85	79.7
Gluten, fat, &c., -	0.2				0.3
Casein, - -	0.16				
Starch, -					9.7

The apple, if of good quality, may be regarded equally, if not more rich in fat-producing products than the potato. The apple is also richer in nitrogenous, or flesh-forming, products; and its inorganic constituents are peculiarly valuable. (*Salisbury,* in Trans. of N. Y. Soc'y, vol. ix. pp. 737—743.)

640. Inorganic analysis of a Sweet Apple Tree; 19 years old. (*Emmons.*)

	Bark.	Outside wood.	Heart wood.	Bark of root.	Wood of root.
Potash, - -	0.44	3.288	2 75	0.66	15.07
Soda, -	1.53	3.33	1.62	11.38	21.99
Chloride of sodium, -	0.30	0.33	0.51	0.10	0.11
Sulphuric acid, -	38.39	12.21	22.17	30.83	1.84
Carbonic acid, -	49.56	15.79	38.98		
Lime, - -	1.86	15.56	2 66	1.00	11.64
Magnesia, - -	2.56	3.52	2.93	8.72	0 16
Phosphate of iron,				0.72	0.91
Phosphate of lime, -	3.60	37.50	24.40	6.39	13.96
Phosphate of magnesia,				......	31.35
Organic matter, -	3 35	3.20	3.60	1.80	1.20
Insoluble silica, -	1 26	0.45	0.20	2.86	1.46
Coal, - -	1 26	0.35	0.01	0.72	

641. Inorganic analysis of the leaves of the Early Harvest Apple, collected September 30: bearing fruit. *(Emmons.)*

Silica,		5.775
Phosphate of iron,	4.875	
Phosphate of lime,	1.416	
Phosphate of magnesia,	trace	
Silica,	5.125	
Phosphoric acid,	5.359	16 775
Lime,		36 398
Magnesia,		0.075
Potash,		13.179
Soda,		11.616
Chloride of sodium,		0.060
Sulphuric acid,		0.137
Carbonic acid,		15.200
Organic matter,		2.850

PROPORTIONS.

Water,	54.341
Dry,	45.659
Ash,	4.194
Ash, calculated dry,	9.163

642. THE PEAR *(Pyrus communis,) (a,)* a native of Europe, cultivated from remote antiquity; *(b,)* at present, Belgium is celebrated for this fruit; *(c,)* several fine American varieties; *(d,)* propagated by seeds, (for stocks,) by grafting—budding—dwarf pears on Quince roots; *(e,)* requires a soil rich in the *phosphates*, much more difficult to cultivate than the last; *(f,)* subject to several diseases, from the seed to maturity, as *Insect-blight, Frozen-sap-blight*, &c; *(g,)* ripened artificially in the house, to acquire perfection of flavor; *(h,)* brings high prices in market; *(i,)* Perry—manufacture *(i,)* manures, unleached ashes, bones, lime, plaster, salt.

643. Comparative analysis of the Sap-wood (A,) Heart-wood (B,) Bark of Trunk (C,) of the Pear Tree, and the Wood (D,) and Bark (E.) of the Root of the same. *(Emmons.)*

	A	B	C	D	E
Water, - -	48.80	22.05	63.70	22.33	58.80
Dry matter, -	37.20	77.95	30.30	79.67	46.20
Ash - -	0.20	0.10	1.99	0.40	3.26

644. Analysis of the leaves of the Bergamot Pear tree, (collected September 30, bearing fruit;) (A,) and of a Pear tree, (picked May 23, flowers just fallen,) (B.) *(Emmons.)*

	A		B
Silica, -	4.250	Silicic acid, -	1.750
Phosphates, (with 5 bases,)	16.550	-	25.050
Lime - -	39.853	- -	:4.715
Magnesia, -	5.920	- -	4.500
Potash, - -	8.793	- -	18.950
Soda, -	——	- -	15.190
Chloride of Sodium,	0.554	- -	not determined
Sulphuric acid, - -	4.464		do
Carbonic acid, -	17.125	- -	11.560
Organic matter, -	3.000	-	not determined

Proportions of (A,)

Water, - - -	56.138
Dry matter, - - -	43.862
Ash, - - -	3.260
Do. calculated dry, - - -	7.514

For the organic analyis of the fruit, see (S——)

645. QUINCE *(Pyrus Cydonia,)* *(a,)* native of the South of Europe; *(b,)* varieties few, cannot be eaten uncooked, seeds medicinal; *(c,)* propagated by seed—cuttings—grafts—layers. *(d,)* cultivation simple; *(e,)* injured by the *Borer*, and a worm that girdles the twigs; *(f,)* manures,—barn-yard—salt—woolen rags.

646. The tree and fruit do not appear to have been analyzed. Souchay gives the following inorganic constituents of the seeds:

Potash, - -	27.09	Oxide of iron, - -	1.19
Soda, - - -	3.01	Phosphoric acid, -	42.02
Lime, - -	7.69	Sulphuric acid, - -	2.67
Magnesia, - -	13.01	Chloride of Sodium,	2.57
Silica, - -	0.75		

647. PEACH *(Persica vulgaris,)* *(a,)* native of Persia; said to have been found cultivated abundantly by the Indians by Hendrick Hudson, on his first voyage, but never discovered wild on this continent; supposed to be a cultivated variety of the almond *(amygdalus communis,)*; *(b,)* in Great Britain requires artificial heat; *(c,)* varieties exceedingly numerous; *(d,)* propogated by seed—budding—(grafting, and in New Zealand by cuttings); *(e,)* cultivation simple, pruning chiefly confined to *shortning in*; *(f,)* dried; *(g,)* fattening for hogs—owing to the *Cyanogen* of the kernel? *(h,)* distilled into brandy; *(i,)* manures —leached ashes; *(j,)* injured by the *Borer*, the *Aphis*, the *Curculio;* and diseases—the *Yellows*, *Curl*, &c.—causes and remedies.

648. Inorganic analysis of the leaves of the Peach tree, (pulled July 22), (A,) and of the leaves of a tree affected by the Yellows, (B,) *(Emmons.)*

	A	B
Carbonic acid, - - -	13.300	13.200
Silicic acid, - - -	0.600	0.800
Phosphates, - - -	9,600	11.600
Lime, - - - -	16.220	14.300
Magnesia, - - -	5.900	5.300
Potash, - - - -	14.280	14.440
Soda, - - -	21 220	22.280
Chlorine, - - - -	5.120	4.740
Sulphuric acid, - - -	4.420	4.430
Organic acids, - - - -	7.900	4.300

These analyses are peculiarly interesting, as showing that the disease called the "yellows" does not arise from a deficiency of inorganic matter. Should further examinations sustain this view of the case we may be enabled to find a remedy for this scourge of the peach tree. We throw out the suggestion, that, owing to the constant generations of plants on the same soil, a change takes place similar to that observed when animals are bred in-and in; or in other words a scrofulous constitution be-

comes inherent, which causes the absorption of too great proportions of inorganic salts, and thence disease, and early mortality. We cannot in this place do more than hint at this subject, but many facts and analogies may be adduced in support of this theory, and we submit it to the consideration of those who live in a part of the country where this disease prevails. In some soils, if long continued wet weather occurs in the early part of the summer, the leaves of this tree, even when perfectly healthy, become diseased, curl up, and fall off; an affection which we are inclined to attribute to an inordinate absorption of salts, but are, as yet, unable satisfactorily to prove it.

649. Inorganic analysis of a small seedling Peach tree, aged 23 years; mean diameter 3½ inches; thickness of bark 1-7 inch; growth rather slow. *(Emmons.)*

	Bark of Trunk.	Wood of Trunk.	Bark of Root.	Wood of Root.
Potash,	1.20	7.11	3.162	8.58
Soda,		11.15	1.92	15.92
Chloride of Sodium,	0.04	0.16	0.33	5.60
Chloride of Potassium	——	——	——	——
Sulphuric acid,	4.19	1.51	3.44	0.58
Carbonic acid,	——	——	——	——
Lime,	42.17	23.26	38.48	0.11
Magnesia,	2.16	6.40	2.91	0.01
Phosphate of iron,	0.45	0.32	10.40	1.02
Phosphate of lime	18.79	29.19		18.10
Phosphate of magnesia,	0.01	1.34	——	30.00
Organic matter,	3.30	5.20	3.60	2.55
Insoluble silica,	4.15	1.35	9.40	6.46
Coal,	——	——	1.40	——
	Leaves.	**Pits.**	**Bark of Limbs.**	**Wood of Limbs.**
Potash	12.41	18.47	8.55	19.21
Soda,	——	5.21	——	8.11
Chloride of Sodium,	——	2.70	0.28	0.24
Chloride of Potassium,	0.36	——	——	——
Sulphuric acid,	12.12	15.12	6.18	8.07
Carbonic acid,	——	——	——	——
Lime,	14.77	16.80	31.98	24.64
Magnesia,	8.00	1.33	6.00	9.76
Phosphate of iron,	2.47	1.33	1.60	0.60
Phosphate of lime,	10.44	17.98	8.50	13.20
Phosphate of Magnesia,	3.15	0.02	0.20	0.20
Organic matter,	0.86	6.64	5.00	8.40
Insoluble Silica,	6.42	10.00	4.30	1.00
Coal,	4.48	——	1.00	1.20

For organic analysis see § ——

650. The kernels, blossoms, leaves, and bark, possess poisonous qualities, apparently independent of the *hydrocyanic (Prussic) acid*, contained especially in the first. *(Pereira.)*

651. THE NECTARINE *(Persica lœvis,)* is distinguished from the Peach by its smooth fruit; but it is believed to be merely a variety of the latter. In the United States it is rarely cultivated in consequence of the great injury done to it by the Curculio.

652. CHERRY *(Cerasus vulgaris,) (a,)* native of Asia, *(b,)* varieties numerous as *Heart, Bigarreau, Duke, Morello*, each of which has many sub-varieties. Best in France; many good American varieties, especially those produced by hybridizing by Dr. Kirtland, of Cleveland, O.; *(c,)* propagated by seeds—(for stocks and new sorts)—by budding—(grafts;) dwarfed by budding on the Perfumed Cherry *(C. Mahaleb;) (d,)* cultivation; pruning simple,—branches should be trained near the ground, with a short stem. *(e,)* Manures,—bones, ashes, salt, plaster.

653. Analysis of the leaves of the Oxheart Cherry, (picked, May 23rd,) (A;) and of the leaves of the Large Yellow Spanish Cherry, (picked, September 30,) (B.) *(Emmons.)*

	A.	B.
Carbonic acid,	11.450	
Silicic acid,	1.850	
Phosphates,	26.650	37.175
Lime,	3.941	21.975
Magnesia,	3.465	3.195
Potash,	23.757	13 948
Soda,	12.367	1.657
Sulphuric acid,	not determined.	10.260
Organic acids,	do	7.650
Silica,	do	4.225
Chloride of sodium,	do	0 410

PROPORTIONS OF THE LAST, (B.)

Water,	58.628
Dry matter,	41.372
Ash,	3.434
Ash, calculated dry,	8.300

For organic analysis, see §

654. THE PLUM *(Prunus domestica,)* is a native of Europe, with four indigenous species in the Northern United States. Owing to the destruction of the fruit by the Curculio, the culture of this tree has become insignificant. The principle inorganic constituents are Potash, Soda, Lime, and Phosphoric acid. *(See Patent Office Report,* '49, p. 480.) Many modes of preventing the attacks of the Curculio have been proposed, but none have proved entirely effectual. Dusting the tree with slaked lime is, at present, looked upon with most favor.

655. GRAPES *(Vitis,) (a;)* European grapes originally from Persia. Quite distinct species from native American Grapes, of which there are many species and varieties. *(b,)* European grapes difficult to cultivate in America. Large vineyards on the Ohio River, and other States south of that. *(c,)* Propagated by layers,—cuttings,—eyes,—grafts. *(d,)* Cultivation and pruning demand much skill and knowledge. Subject to a mould on the fruit, curable by sulphur.

656. Inorganic analysis of the leaves of the Catawba Grape, picked, June 2d, nearly full grown (A,) and the same picked, September 30, fruit abundant (B.) *(Emmons.)*

	A.	B.
Carbonic acid,	3 050	8.900
Silicic acid,	29.650	Silica 23.150
Sulphuric acid,	2 062	1.426
Phosphates,	32 950	28.750
Lime,	4.391	26 258
Magnesia,	1.740	5.330
Potash,	13.394	1.710
Soda,	9.698	2.983
Chlorine,	0.741	
Organic acids,	2.250	3.450
Chloride of sodium,		0.305

From Grapes are made: 1. Grape Sugar. 2. Bitartrate of Potash, (*Crude tartar or Argol.*) 3. Raisins, and small black "currants" imported from the Mediterranean. 4. Wine. 5. Brandy.

657. GOOSEBERRY *(Ribes Grossularia,) (a,)* native of Great

Britain—many cultivated sub-varieties—4 wild species in the northern United States—prefers a damp climate and soil; *(b,)* colors vary, red, yellow, green, differs also much in size, and in the prickles on the fruit; *(c,)*, propogated by cuttings—layers, suckers, *(c,)* cultivation simple, best in the U. S. in a damp, shaded place, or well mulched especially with salt-grass—pruning, annual shortening in, keeping the centre open to admit air; *(d,)* manure, ashes, salt, well-rotted organic matter; *(e,)* a mould similar to that on grapes, often destroys the fruit.

658. Organic analysis of the unripe (A,) and the ripe Gooseberry (B.) *(Berard.)*

	A	B
Chlorophyl and coloring matter - -	0,03	
Sugar, - - -	0.52	6.24
Dextrine, - - -	1.36	0.78
Fibre, - - -	8.45	8.01
Albumen, - - -	1.07	0 87
Malic acid, - - -	1.80	2.41
Citric acid. - - -	0.12	0.31
Lime, - - -	0.24	0.29
Water, - - - -	86.41	81.10

The leaves of the CURRANT are rich in Soda and the Phosphates; the blossom, in Potash. *(Emmons.)*

659. RHUBARB; *(Rheum rhaponticum,)* *(a,)* many species cultivated, from Asia, China, Turkey, and Tartary; many sub-varieties produced by cultivation; *(b,)* the petioles, or leaf-stalks, used for pies, preserves, making wine; the root as medicine—the best from Russian Tartary, on the confines of China—the root grown in Europe and America very inferior as a drug; *(c,)* cultivation requires deep rich soil, highly manured, and the plants covered during the winter with rough barn-yard manure—is sometimes *blanched*, by which the flavor is improved; *(d,)* the leaf, flower, stalks &c., poisonous, chiefly in consequence of the *Oxalate of lime* contained in them, which is decomposed in digestion; *(e,)* specific manures, bones—plaster—salt—ashes —organic substances.

660. Percentage of Water, Dry matter, and Ash, in various parts of the Giant Rhubarb, cut June 1, Plant in flower. *(Salisbury.)*

	Root,	Stalk,	Petioles,	Leaf-blades,	Flowers & Pedicles.
Percentage of water,	82.000	89 50	93.46	88.00	86.90
—— Dry matter,	18.000	10.50	6.53	12.00	13.10
" Ash,	0 925	1.13	0.94	1.53	1 32
" ash calc. on dry mat.	5.194	10.76	14.384	12.75	10.C7

661. Inorganic analysis of various parts of the same plant—viz—Root (A,) Leaf stalk (B,) Leaf blades (C,) Stalk (D.)

	A.	B.	C.	D.
Silicic acid, - -	3.95	1.40	7.60	0.450
Phosphates, -	30.05	22 20	19.40	17.20
Lime, - -	4.78	2.47	5.74	3.57
Magnesia, -	2.92	0.20	1.16	0.20
Potash, - -	7.21	5.28	7.87	8.09
Soda, - -	24.73	33.26	27.36	33.26
Sodium, - -	0.14	1.65	2.11	0.97
Chlorine, -	0.22	2.50	3 21	1.48
Sulphuric acid, - -	5.15	5.27	4.27	10.72
Organic matter, -	7.35	15.60	6.40	12.15
Carbonic acid, - -	12.05	9.43	14.90	9.40

662. Proximate organic analysis of the Leaf stalks (gathered September 1st) of a very large and succulent Rhubarb.

Percentage of water, - - -	87.77
" of dry matter, - -	12.23
" ash - - -	2.27
" ash calc. on dry matter, -	18.56

	With the Water.	Without the Water.
Fibre with a little starch and chlorophyl,	1.26	9.89
Malic acid and extract, with a little tartaric and oxalic acids,	5.70	44 62
Dextrine, - -	0.55	4.30
Fibre, - - -	3.23	25.30
Matter separated from fibre, albuminous,	1.60	12.55
Albumen, - - -	0.27	2.11
Casein, - -	0.15	1.17
Water, - - -	87.77	——

(*See Trans. N. Y. Agricul. Society, vol. ix, p.* 744.)

663. Comparative analyses of the large red Tomato, *(Sola-*

num lycospersicum,) (A,) and of Egg Plant, *(Solanum melongena,)* (B.) *(Salisbury.)*

I. Percentage of water, dry matter and ash:

	A	B
Water,	94.75	91.35
Dry matter,	5.24	8.64
Ash.	0.33	0.60
Ash, calculated on dry matter,	6.37	6.98

II. Composition of the ash of the above:

	A.	B.
Carbonic acid,	11.05	4.72
Silicic acid,	1.77	1.70
Sulphuric acid,	1.79	4.74
Phosphoric acid and peroxide of iron,	24.07	28.77
Lime,	0.07	0.07
Magnesia,	1.61	1.37
Potash,	20.80	20.51
Soda,	25.53	31.97
Sodium,	2.79	1.13
Chlorine,	4.24	1.73
Organic acids,	4.55	2.20

III. Proximate organic composition of the Tomato:

Sugar and extract, with tartaric, citric and malic acids,	3.32
Albumen,	0.21
Casein,	0.20
Dextrine or gum,	0.54
Fibre with coloring matter,	1.01
Matter separated from the fibre	0.32
Water,	94.75

With a small quantity of volatile oil.

Proximate organic composition of the Egg Plant:—

Sweet water and extract, with a peculiar bitter principle,	3.04
Starch,	0.36
Albumen,	0,25
Casein,	0.20
Dextrine or gum,	0.37
Fibre,	0.76
Matter separated from the fibre,	0.97
Water,	91.35

With a small quantity of volatile oil and wax.

(See Trans. N. Y. Agricul Socy. Vol. viii, p. 370.)

664. ASPARAGUS *(A officinalis,)* owes its flavor and properties to a peculiar, easily crystallizable neutral substance (C_8 N_4 H_{16} O_6 which occurs in several plants, as the Marsh-mallow, Cumfrey, Potato &c, called *Asparagine.*

665. LETTUCE *(Lactuca sativa,)* owes its value to a narcotic principle called *Lactucin.* It acts upon the brain after the manner of Opium, and induces sleep; eaten during the day, it calms, soothes, and allays the tendency to nervous irritability. It is probable that it might be fed with a good effect to fattening animals; in a favorable soil, it is cultivated with great facility. *(See Blackwood's Magazine, Dec.* 1853, *p.* 679.*)*

666. Analysis of the Muskmelon *(Cucumis melo,)* (A;) Watermelon *(Cucurbita citrullus,)* (B;) and Cucumber *(Cucumis sativus,)* (C.) *(Salisbury.)*

Percentage of water, dry matter, and ash:—

	A.	B.	C.
Percentage of water,	90.987	94.898	96 364
" of dry matter,	9 013	5.102	3.636
" of Ash,	2.771	0 248	0.362
" of Ash in dry matter,	3.007	4.861	9.955

Ultimate analysis of the above:—	A.	B.	C.
Nitrogen,	2.231	1.739	1.236
Oxygen,	43.905	43.187	41.806
Carbon,	44.820	43.764	40.984
Hydrogen,	6.832	6.872	6.879
Inorganic matter,	3.007	4.861	9.955

Inorganic analysis of the above:—	A.	B.	C.
Carbonic acid,	11.55	11.42	13.25
Silicic acid,	2.20	1.21	0.70
Phosphoric acid,	25.40	14.93	18.90
Sulphuric acid,	3.90	1.63	0.90
Phosphate of iron,	2.30	4.52	3.10
Lime,	5.85	7.32	4.30
Magnesia,	0.60	1.31	0.20
Potash,	8.35	23 95	23 20
Soda,	34.35	30.63	33.75
Chlorine,	5.20	1.81	1.10
Organic matter,	trace,	trace,	trace.

Proximate organic analysis of the above *(fresh,)*:—

	A.	B.	C.
Albumen,	0.918	0.572	0.356
Casein,	0.442	0.004	0.040
Dextrine,	1.142	0.318	0.354
Starch,	trace,	none,	0.002
Sugar and extract,	5.250	3 020	2.826
Chlorophyl,	0.004	0.006	0.006
Fat, wax, and resin,	0.038	0.022	0.031
Citric acid,	trace,	0.007	
Malic acid,	0.007	0.009	
Tartaric acid,	0.0(5	trace.	
Fibre,	1.123	1.058	9.61
Water,	90.987	94.898	95.354

The varieties above examined were the *Nutmeg Muskmelon;* the *Long Red Watermelon;* and the *Early Long Prickly Cucumber.* (See further, *Trans. of the N. Y. Agricul. Socy.*, vol. xii., (1852,) pp. 335—337.)

667. Analysis of the Vegetable Oyster-root—*Tragopogon porrifolius,)* (A;) of the Endive or Succory-leaf—*Cichorium Endivia,)* (B;) and of Celery, *(Apium Graveolens,)* (C.)—*(Salisbury in Trans. of N. Y. Agricul. Socy.*, vol. xii.)

Percentage of water, dry matter, and ash:—

	A.	B.	C.
Percentage of water,	81.22	91.925	88.225
" of dry matter.	18.78	8.075	11.775
" of ash,	1.465	1.010	1.375
" of ash in dry matter,	8·333	12.507	11.931

Ultimate analysis of the above:

	A	B	C
Nitrogen,	0.995	2.170	2.121
Carbon,	42.044	41.171	40.626
Oxygen,	44.017	40.257	40.352
Hydrogen,	5.058	5.617	5.371
Inorganic matter,	8.860	12 507	11.931

Inorganic analysis of the above:—

	A	B	C
Carbonic acid,	24.60	13.80	20.80
Silicia acid,	0.60	20.80	5.60

	A	B	C
Phosphoric acid,	15.60	9.90	5.40
Phosphate of iron.	1.85	2.95	4.95
Lime,	4.95	8.05	13.55
Magnesia,	0.75	3.65	0.90
Potash,	5.80	8.90	7.25
Soda,	39.20	27.80	28.80
Chlorine,	2.45	1.40	1.40
Sulphuric acid,	3.90	2.10	10.30
Organic matter,	trace.	——	——

Proximate organic analysis of the above:—

	A	B	C
Water,	80.610	91.925	88.225
Fibre,	2.764	1.348	3.168
Sugar and extract,	3.665	4.300	5.685
Dextrine,	1.435	0.735	0.905
Casein,	0.172	0.100	0.115
Albumen,	1.066	1.320	1.532
Starch,	0.035	none.	none.
Resin,	0.180	0 260	0.185
Gluten,	0.014	0.055	0.095
Chlorophyl,	——	0.052	0.055
Wax,	——	0.055	and oil 0.120

CHAPTER XXII.

MANURES.

668. In order to understand the principles of manuring we must consider:—

(*a*,) A plant consists of two parts, an organic and a mineral part. The mineral part is drawn from the soil alone, by the roots; while of the organic part one portion comes from the soil through the roots, and another portion from the air through the leaves.

(*b*,) The organic part of plants consists of four simple bodies, or gases; carbon, hydrogen, oxygen, and nitrogen. In all the parts of plants these four are associated also, with minute quantities of sulphur and phosphorus.

(*c*,) Of these four substances nitrogen appears to be drawn by the plant almost exclusively from the soil; the hydrogen and oxygen are drawn partly from the soil and partly from the air—chiefly in the form of water. The carbon is derived only in small proportion from the soil, being for the most part sucked in from the air by the leaves, in the form of carbonic acid gas. Sulphur and phosphorus come from the soil only.

(*d*,) The mineral part of the plant, which forms from half of one per cent. to 15 to 20 per cent. of the whole weight of the dried plant, consists of about 12 different substances. (*See* § 93, *p.* 27.) Of these silica exists chiefly in the stems of grasses, grains, &c., and in smaller proportion only in the softer parts and juices of plants. Potash, soda, chlorine and sulphuric acid are, for the most part, found in the sap; lime, magnesia, and oxide of iron in the solid parts of plants. Phosphoric acid is necessary to, and is found in every part of a plant, but it collects in larger proportion in the grain or seeds as the season of ripening approaches. (*See Johnston's Experimental Agriculture, p.* 7.)

(*e*,) No plant therefore can flourish and come to maturity unless it is able to procure in a proper form, and absorb the above substances.

669. We must consider also:—

(*a*,) That a fertile soil consists of three portions, 1. Of one which is dormant, as the sand and clay which form by far the larger mass of it; 2. Of the above minerals and organic matter in a state in which they are *insoluble* in water, and therefore cannot become part of a plant; and 3. Of the same in a *soluble* form capable of dissolving in water, and of entering into the pores of the roots. (*See* § 113, *p*. 34.)

(*b*,) That every crop which is taken off the ground carries away a notable portion of the soluble materials; and, supposing that there existed no means of adding to them, all soil would rapidly become exhausted by cultivation.

(*c*,) But nature is continually rendering soluble that which she finds insoluble in the soil, by the action of the air, of carbonic acid gas, by heat, electricity, moisture, and complex chemical changes which are always in progress. Again, a porous soil into which air and water can find their way, is constantly receiving additions from the atmosphere, and from spring water laden with soluble salts, raised by evaporation and capillary attraction. (*See* § 29, *p*. 9, § 55, *p*. 17.)

(*d*,) If, therefore, we were content to commence cultivating a virgin soil, abounding in all that is requisite to form a plant; to take off one grain crop; and then leave the field uncultivated for a certain number of years, we might in this manner retain the fertility of the soil, and at each period reap an equally large crop, for any length of time.

(*e*,) But this mode of cultivating the soil is *unprofitable;* and, therefore, the ingenuity of man has discovered various modes of hastening or dispensing with the action of nature. These modes are 1. A *b re fallow*, where two grain crops were taken in succession, and then the land was left unfruitful for a year, but frequently plowed and stirred so as to expose every part of it to the dissolving action of the elements. 2. *Rotations*, so arranged that each succeeding crop abstracted only such materials as were not required by the other crops; so that when grain was again sown it found an accumulation of those peculiar elements which were requisite for its prosperity. 3. *Draining*, whereby the soil was rendered porous to a considerable depth, and enabled to receive and retain such elements as the air and water were capable of supplying; and 4. *Manuring*, which is procuring from some other source, and applying directly to the soil the elements necessary for the crop; or, in other words placing in the ground the raw material which nature is to work up into grain; as the paper-maker collects old rags, out of which white paper is to be made. (*See* ***Farmer's*** *Companion and Horticultural Gazette*, Vol. ii, p. 89.)

(*f*,) Manuring, therefore, may be defined to be the directly supplying

to the soil those constituents which are necessary for the formation of the plant we wish to grow, and which, in a soluble shape, are either naturally deficient in the soil, or have become so by our carrying them off in the form of grain, meat, &c., we not being able to wait until nature performs this work for us,*

670. Manuring is probably the most costly mode of restoring the fertility of the soil that can be practiced.

671. But while many persons are content merely to retain, by manuring, their land at its natural point of fertility, others render it much more fertile than it ever was; on the principle that if a certain quantity of applied manure can be worked up into a grain crop, a still greater quantity will supply a larger proportion of grain.

672. From this it must be apparent that in order that a farmer may economically and skilfully manure his land, he must understand the composition of plants, the relative materials which constitute his soil, the constituents of the manures applied, and their chemical action. For were he to put on his field a salt in a soluble form which would immediately become insoluble in consequence of chemical changes, the manure would be lost to him.

In the following pages we shall chiefly confine ourselves to an account of the manures which are generally available in the Northern States, and the principles on which they act. For further information on this extended and intricate subject we must refer the reader to works especially bearing upon it.

673. The following diagram from *Dumas & Boussingault's Chemical and Physiological Balance of Organic Nature,* may be useful in this connection.

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*A species of manurnig may be practiced, the principle of which differs from the above; as where a salt is applied, *not* for the purpose of directly entering into the plant, but to act, chemically, as a solvent, upon the insoluble constituents of the soil; or as a fixer of gases, or other too readily soluble materials, as charcoal and probably plaster.

AN ANIMAL is AN APPARATUS OF COMBUSTION;	A VEGETABLE is AN APPARATUS OF REDUCTION;
Possesses the faculty of Locomotion;	Is fixed;
Burns Carbon,	Reduces Carbon,
Hydrogen,	Hydrogen,
Ammonium,	Ammonium,
Exhales Carbonic acid,	Fixes Carbonic acid,
Water,	Water,
Oxide of Ammonium,	Oxide of Ammonium,
Nitrogen;	Nitrogen;
Consumes Oxygen,	Produces Oygen,
Neutral nitrogenized matters,	Neutral nitrogenized matters,
Fatty matters,	Fatty matters,
Amylaceous matters,	Amylaceous matters,
sugars, gums;	sugars, gums;
Produces Heat,	Absorbs Heat,
Electricity;	Abstracts Electricity;
Restores its elements to the air,	Derives its elements from the air,
or to the earth;	or from the earth;
Transforms organized matters	Transforms mineral matters into
into mineral matters.	organized matters.

673. Manures are generally classed under three heads:—(*a*,) vegetable; (*b*,) animal; (*c*,) mineral. Those that are of vegetable origin being formed of decaying vegetable matter, consist, like the plant, of an organic and mineral part; of which the former is usually much the larger in quantity· But a new branch of study is connected with the decay or decomposition of this vegetable matter, and especially of its organic part, in the farm-yard, in the compost heap, or in the soil. This decay gives rise to new chemical combinations, which have much influence on the efficacy of the decomposed matter as a manure. The nature and products of this new series of chemical changes ought to be familiar to the farmer.

674. Those manures which are of animal origin resemble, in composition, the parts of the animal body from which they are derived—the blood, flesh, bone, &c. Or, if they consist of urine and dung of animals, they have a certain relation, especially the solid excrements, to the food on which the animals have lived. Here, however, a new kind of information is demanded. These animal substances, like the vegetable, putrify before they become directly useful to plants. In the bodies

of animals, also, changes take place, by which the food consumed is decomposed, and new compounds of much importance are, in consequence, introduced into the urine and dung. All these changes are, in some degree, connected with the richness and fertilizing quality of animal manures, or with the special action of the variety which may be used. To know on what the general efficacy or peculiar effect of such manures depends, their changes and the substances produced by them, should be understood. How different samples of the same kind of manures differ in virtue; how this virtue is modified, lost, preserved, or augmented—these questions are of much consequence in ordinary farming, if the best, or most profitable results are to be obtained by the practical man.

675. Mineral, or saline manures are combinations, or mixtures of different combinations of one or more of those mineral substances which exist and are found in living plants. These saline substances are fixed and definite in their composition. But to use them right—to apply them in the proper place, at the proper time, and in the proper quantity —to understand their action, how they ought to be mixed, and why their effects vary in different circumstances and localities—all this requires that they should be thoroughly known, and their mode of action, as single substances and as mixtures understood. (*See Johnston's Experim. Agricul., p.* 246.)

676. In order to show the very complex action of plants and manures on the soil, we extract the following curious and instructive account of an experiment by a practical English farmer, from the *Journal of the Royal Agricul. Socy. of England, vol. xiii. p.* 417.—1852. It is worthy of careful study, and shows more clearly than any other document we are acquainted with, the difficulties which beset the farmer in the management of his crops and manures:

"In the autumn of 1846, a field of three acres was manured at the rate of 20 tons of farm-yard manure per acre, and sown with rye for soiling in the following spring. It produced a very heavy crop, but on account of the stalks becoming too hard for the horses, half the rye was allowed to remain for seed. The part of the field which had been cut for soiling was immediately plowed and sown with globe turnips, with a dressing of three cwt. of Peruvian guano per acre. The turnips were very fine. After the seed rye was harvested and the turnips cleared, the whole three acres were plowed and set with beans the following February; and now comes the curious part of the affair. The beans came up well all over the field; but a difference was soon perceived between those on the seed-rye and turnip ground, the former looking much more luxuriant than the latter, but we were not prepared for what afterwards took place. The beans that followed the turnips actually stopped all growth when six inches high, and, of course, did not seed, whereas, after the seed-rye they grew so luxuriantly as to injure the produce, and this difference extended to the line where we had discontinued cutting the green-rye—the more conspicuous as we had stopped in the middle of a land.

The result certainly astonished me, for it was in direct antagonism to all preconceived notions of farmers; as it is usually thought by them that crops do not impoverish the ground, nearly to the same extent when cut green, as when allowed to ripen their seed. Turnips, too, are generally supposed to extract the greater portion of their nourishment from the atmosphere. But here we find that beans actually refused to grow after the green-rye and turnips, notwithstanding the application of three cwt of guano, and the land being in much better tilth; where the rye was allowed to ripen its seed, and no extra manure applied they grew luxuriantly.

I determined to inquire whether the researches of chemists would throw any light upon the question; and the difficulty I had in compiling the following small tables, fully accounts to my mind for the fact that chemistry has hitherto received so little assistance from practical farmers.

Probable Amount of Ingredients abstracted from or restored to One acre of Land by the several Crops and Manures of Rotation I, (Seeded Rye and Beans.)*

For one acre of land in lbs.	Carbon	Hydrogen,	Oxygen	Nitrog'n	Potash	Soda	Lime	Phosphoric acid.
Amount added to soil by barn-yard manure,	3320	400	2380	180	140	40	280	140
Ditto by seed Rye,	56	6	53	2	0.7	..	..	1
Total added for rye crop,	3376	406	2433	182	141	40	280	141
Amount abstracted by ditto	2169	245	1868	34	25	0.1	10	14
Balance after rye crop,	1207	161	565	148	116	40	270	127
Am't added by seed beans	101	15	86	13	3	..	1	2
Balance left for Bean crop,	1303	176	651	161	119	40	271	129
Amount required by ditto	?	?	164?	?	55	8	37	29
Balance,	?	?	?	—3	+64	+32	+234	+100

Rotation 2, (Green Rye, Turnips, and Beans.)

For one acre in lbs.	Carbon	Hydrogen.	Oxygen.	Nitrog'n	Potash	Soda	Lime	Phosphoric acid.
Amount added to soil by barn-yard manure,	3320	400	2380	180	140	40	280	140
Ditto by seed rye,	56	6	53	2	0.7	..	..	1
Tot'l add for green rye crop	3376	406	2433	182	141	40	280	141
Amount abstracted by ditto	1499	168	1233	12	17	..	9	4
Balance after ditto	1877	238	1200	170	124	40	271	137
Am't added by 3 cwts guano	?	?	?	48	10	4	38	49
Balance left for turnip crop,	?	?	?	218	134	44	309	186
Am't abstracted by ditto	?	?	?	159	166	5	102	33
Balance left after the 2 crops	?	?	?	59	—32†	39	207	153
Am't added by seed leaves,	101	15	86	13	3	..	1	2
Balance left for bean crop,	?	?	?	72	—29	39	208	155
Am't required by ditto	?	?	?	164?	55	8	37	29
Balance	?	?	?	—92	—84	+31	+171	+126

*Mr. Hemming calculated in the same manner *every* constituent of the plant, but the size of our page obliges us to give those only which are most essential to growth.

(†The mark (—) means *minus*, or that the turnips abstracted 32 lbs. more Potash, than had been supplied to the soil by the manure and other sources. In the last line,

When we come to compare the balance left in the soil after these two rotations, supposing the bean crop to have succeeded in both, we find that with the green rye and turnips there is a large deficiency both of nitrogen and potash, that of the latter amounting to 84 lbs. per acre, or in other words the soil would have had to supply 84 lbs. of potash, in addition to that supplied by the manure in order to grow a crop of beans, whereas in the rotation where the rye was allowed to stand for seed, there was a large excess of potash, and a sufficiency of nitrogen."

The above also elucidates a principle which the practical farmer should never lose sight of; viz, that a field may prove barren for a given crop, such as wheat, from the deficiency of only *one* or *two* constituents; and that, in order to supply this deficiency, our cheapest course generally is to give to the soil that peculiar material. Suppose I have a field which refused to grow wheat, in consequence of impoverishment. Am I to supply barn-yard manure, which contains *every thing* the wheat crop can require, but which is costly owing to the quantity which I must haul from a distance and spread? or shall I apply 3 cwt of guano, and 100 pounds of super-phosphate of lime, on the supposition that nitrogen and phosphoric acid alone are wanting? In the Michigan Oak openings we have reason to believe that it is a deficiency of these two materials only which renders the soil less fertile than it used to be; but a chemical analysis can alone positively decide the matter. In *practice* the question would be one of cost, supposing the barn-yard manure to be good: but the amount of *common* dung requisite to supply the nitrogen, phosphates and potash of the above named guano and bones, would have to be very much larger than we are in the habit of using to the acre. The above also teaches, that while a field may refuse to grow one crop profitably, it may be quite capable of growing another and different class of plants.

677. Before manures can produce their full and profitable effect upon the soil, the land must be laid dry by drainage or other means. It must also be cleaned and kept clean from weeds.

678. The value of the various constituents of manure may be thus classified; and the money cost, in the Western States, of any given manure can easily be estimated by the quantity of the following ingredients which it contains, in a *soluble* form.

1. Nitrogen.	7. Potash.
2. Ammonia.	8. Magnesia.
3. Phosphoric Acid.	9. Iron and Manganese.
4. Sulphuric Acid.	10. Lime.
5. Soda.	11. Carbon.
6. Chlorine.	12. Soluble Silica.

679. It is impossible to ascertain by theory alone and without actual experiment, the exact effect which a given manure will produce upon a given soil or crop. The mechanical con-

it shows that there were 92 lbs. less nitrogen and 84 lbs. less potash than the bean crop required, and it appears to be taken for granted that the soil contained none of these constituents except where they had been artificially supplied.)

struction of the soil, the climate, the season, the mode of cultivation, the salts already contained in the earth, but especially the period, mode, and form in which a manure is applied, all combine in influencing the final result. *Theoretically*, the value of a manure depends upon the amount of nitrogen which it contains, but, *practically*, this does not *always* prove to be the case; and in some instances, a salt, such as gypsum, wholly devoid of nitrogen, may return a larger crop than any nitrogenous manure we can apply. The rule, however, is general in its application, the exceptions comparatively few. The form of a manure, and the way in which we apply it are, in practice, of chief importance. Thus, in most instances, barn-yard manure well prepared and well rotted, is very superior in action to "long dung," unfermented, and with the vegetable matter undecayed. Yet there are soils and crops for which the latter is preferable. Again, bones owe much of their efficacy to the manner in which they are prepared. Whole bones, boiled bones, crushed or ground bones, bones dissolved in sulphuric acid, and applied in a powder, or in a solution with water, all differ in their effects and profitable results. Thus, in an English experiment, it was found that—

16 bushels of crushed bones gave 10 tons 3 cwt. turnips per acre.
2 " bones dissolved in acid and applied dry gave 11 tons 15 cwt.
4 " " " " " 14 " 11 "
8 " " " " " 16 " 1 "

But when applied in a *liquid form* at the time of sowing, the effect was still more remarkable, thus:—

	Tons per acre.
16 bushels of bone dust (dry) produced	11 of turnips.
8 " dissolved in 83 lbs of acid dried up and sown with the hand produced	11 "
While 2 bushels, with 83 lbs. of acid, and 400 gallons water produced	12½ "
And, again, in a third locality in Scotland, 76 lbs. of bones, 46 lbs. of acid, and 400 gallons of water produced	17½ "
While 440 lbs. of bones, with 28 lbs. of acid applied dry, produced only	17 "

The same rule appears to hold good as regards barn-yard manures. In Flanders and Switzerland they have long been dissolved in water previous to application, and, of late years, in Great Britain, the steam engine has been employed for this purpose, and the liquid carried over the farm in iron pipes, similar to those used for Hydraulic works in our cities; the extra power of the manure being supposed to cover the greatly increased cost of preparation and application. *(See Prof. J. W. F. Johnston's Essay on Manures, written for the Farmer's Companion and Horticultural Gazette, vol.* 1, *p.* 98.) So in the same manner, Plaster has been found to act more efficiently when plowed in, instead of being scattered over the surface, and newly and finely ground gypsum is understood to act more efficiently than that which is coarse, and long kept, even in tight barrels. And again, common salt has been applied with beneficial results, in large quantities, to fruit trees in one locality, while a smaller application has killed trees in another.

There is no one subject in agriculture which demands, at the present day, more careful, continued, and widely extended experiments than the practice of manuring. Of the positive and relative constituents of common manures, the best quantities to apply, the condition in which, and the time when they should be used, the average effect which they produce, and the money profit derived from their application, we regret to believe that the great proportion of practical farmers are quite ignorant; and there can be no doubt but that this ignorance causes great individual and national losses.

680. I.—Animal Manures.

Flesh, is a rich manure in itself, and the rapidity with which it decays, enables it to bring other organic substances into a state of active fermentation. It is a very compound substance, in the shape in which we generally meet with it—that of dead animals—consisting of the lean muscle, or *Fibrin;* of fat or oil; and of blood, which again consists of Fibrin, Albumen, *(white of egg,)* coloring matter, several salts and water; while connected with the flesh are hair, horns, hoof, tendons, bones,

again differing from the first in their relative composition. The only flesh, usually, at the farmer's disposal is that of animals accidentally dying, or, near cities, the refuse of the slaughter houses. A dead animal, if large, should be cut to pieces, and mixed with six or eight times its weight of peat, muck, earth, or even barn-yard manure; with plaster and salt; being sheltered from the rain; the whole of which will be converted into a very rich compost. A horse will supply sufficient ammonia to grow an acre of wheat.

681. An ox, on the average, yields of

Saleable meat -	58 per cent	Tallow, - -	8 per cent
Skin, -	5½ per cent.		

The marketable meat contains,

Dry bone,	10 per cent	Muscle, with blood, lymph &c	16 p. ct.
Cellular tissue & fat	5 "	Water, - -	71 "

The chemical composition of flesh and blood is almost identical, so that blood may be called liquid flesh, and *vice versa;* the solid or liquid state being more dependent upon structure than upon the amount of water—blood only containing 3 per cent more water than flesh.

682. Ultimate analysis of Dry Beef (A,) and Dry Ox Blood, (B.) *(Playfair and Beekman.)*

	A	B
Carbon, - - -	51.83	51.96
Hydrogen, - - -	7.57	7.25
Nitrogen, - - -	15.01	15.07
Oxygen, - - -	21.37	21.30
Ashes - - -	4.22	4.42

683. Inorganic analysis of the Blood of the Ox (A,) Calf (B,) and Sheep (C.) *(Enderlin.)*

	A	B	C
Phosphate of Soda - -	16.77	30.18	13.30
Chloride of Sodium, -	59.34	52.65	66.57
Chloride of Potassium, - -	6.12		
Sulphate of Soda, -	3.85	2.94	5.38
Phosphates of lime and magnesia, -	4 19	3.49	13.92
Oxide and phosphate of iron, -	8.28	9.28	
Gypsum and loss, - -	1.45	1.46	0.83

The reader will notice the large quantity of common Salt *(Chloride of sodium,)* found in the blood of our domestic animals, and as our common forage plants contain but a small quantity of it, he will see the necessity of regularly supplying it with the food. In countries near the Sea, as in Great Britain, sufficient salt is deposited on the grass by the winds and spray, and there, salt is not given to cattle ; but in the West, it becomes an essential necessary of life, and were it not for the "Salt Licks", the Deer and other wild, ruminating animals would perish.

(For the effect of blood as a manure upon wheat, in its yield and composition see *ante* § 177 p 68 ; upon rye § 211, p 87 ; upon barley § 237, p 94 ; and upon oats § 262, 103.

684. Hair, Horn, and Wool, are distinguished from the muscular parts of the animal body, by the large proportion—about 5 per cent—of sulphur which they contain. They consist of a substance, which, in other respects, closely resembles gluten and gelatine in its chemical composition. When burned they leave from one to 2 per cent of ash. The inorganic matter, therefore, is generally the same as is found in the muscular fibre and the bone.

685. Bones are, in reality, that portion of animals, to which, as a manure, the farmer is the most indebted. It has been observed that all useful plants contain *phosphorus*, which is one of the rarest minerals in the soil; which, when in a soluble form, is most rapidly withdrawn; and yet, without which, plants become useless, for the sustenance of animal bodies. It has occurred, that the old pasture lands of Cheshire, England, became impoverished of this element; and although grass continued to grow, it was inferior in quality, and animals fed upon it became diseased, especially as to their bony structure. Till lately bones and brains have been the only available source whence Phosphorus could be procured. The following is the composition of the Ileum of a sheep (A,) of an ox (B,) and the vertebræ of a haddock (C.) *(Thompson.)*

	A	B	C
Organic matter,	43 3	48.5	39.5
Phosphate of lime,	50.6	45.2	56.1

	A	B	C
Carbonate of lime - -	4.5	6.1	3.6
Magnesia, - - -	0.9	0.2	0.8
Soda, - - -	0.3	0.2	0.8
Potash, - - -	0.2	0.1	—

The proportion of water in the bones of quadrupeds varies from 7 to 20 per cent according to the age of the animal, and the fat, or oily matter from 13 to 25 per cent. Those of the ox contain 64.5 per cent of earthy matter, and 35.5 per cent of cartilage; each family differing in this regard.

686. Bones do not benefit plants under all circumstances, and, as has been stated, the form and mode in which they are applied, is of much importance. In Great Britain where they are in especial demand for the turnip crop, it has been the fashion, till of late, merely to grind them in mills built for the purpose; the bones being of different lengths, from fragments 1 inch long to dust; and sometimes boiled, sometimes unboiled bones were preferred. It is now becoming general there, and in the United States, to employ them as *Superphosphate* or *Biphosphate of lime*, that is, dissolved in Sulphuric acid. This may be done by the Farmer himself procuring the ground bones, and in leaden vessels, boiling in Sulphuric acid diluted with water; but according to Johnston, the following is the *true* superphosphate. "When burned bones are reduced to powder, and digested in Sulphuric acid, diluted with once or twice its weight of water, the acid combines with a portion of the lime, and forms sulphate of lime (plaster) while the remainder of the lime and the whole of the phosphoric acid are dissolved. The solution, therefore, contains an *acid* phosphate of lime, or one in which the phosphoric acid exists in much larger quantity than in the earth of bones. The true bi-phosphate when free from water consists of 71½ phosphoric acid, and 28½ of lime." In a manufactured state, however, it is probably never found thus pure; and great complaints have, at times, been made that the manufacturers mix

plaster, earth, salt, and other cheap ingredients with it. When purchasing, the farmer should procure an analysis of the samples and afterwards compare them with the bulk. In Great Britain the manufacture of fictitious and worthless manures is said to have become an extensive trade, the farmers thus losing largely from their ignorance of chemistry. On a small scale, bones may be rendered partially soluble by breaking or grinding, and mixing with fresh wood ashes, to be kept moist for a month or two.

687. In the United States, *Mineral Phosphate of lime* or *Apatite* has been found and dug in considerable quantities at Crown Point, N. Y., and in New Jersey; some of which has been exported to England. So far, the purity appears to differ much, and the expense of mining and dissolving, has discouraged the progress of the works. The following are Dr. Jackson's analyses of pure specimens of the minerals, compared with Prof. Johnston's analysis of bones.

	New York.	New Jersey.	Bones.
Lime,	47.230	92.405	55.50
Phosphoric Acid,	45.710		
Carbonic Acid,	1.218	——	4.00
Lime,	1.554		
Chlorine,	0.130	0.540	——
Calcium,	0,204		
Fluoriae,	0.590	7.012	3.00
Calcium,	0.855		
Protoxide of Iron,	2.000	0.040	
Water,	0.500	——	20.00
Oxide of Manganese,		0.003	
Phosphate of Magnesia,			2.00
Soda and common Salt,			2.50
Gelatine (animal matter,)			33.00

(*See Jour. of Boston Socy. of Nat. Hist.*)

Many *Marls*, especially those formed of recent shell, and some lime rocks, contain notable proportions of the phosphates.

688. Fish are also a valuable manure, where they can be had in quantities. On parts of the New York and New England coasts they are annually caught in vast shoals for this purpose, and the time will come when the streams and lakes of the West

will supply their portion to the soil. The bones and flesh of fish very nearly resemble those of quadrupeds in their phosphates and nitrogen; fish, however, generally affording more free oil. They should always be composted with muck, peat, &c.

689. Shell fish are rarely found sufficiently numerous to be used as a manure, except in a mineral state. In New England, muscles and oyster shells are collected. In Alabama there are vast deposits of this kind; and according to Dr. Houghton *(M. S.,)* much of the marl of Michigan is formed of recent shells. They chiefly consist of lime, a little phosphoric acid, animal matter, and in salt water, iodine, and soda.

690. Barn Yard Manures are composed of the dung and urine of animals, with hay, straw, &c., more or less decayed, and they necessarily differ much according to *(a,)* the species; *(b,)* the age of the animal; *(c,)* the food it eats; *(d,)* the mode in which the dung is preserved, whether exposed to rain, sun, &c.; *(e,)* the quantity of urine contained; *(f,)* the decomposition which has taken place; *(g,)* whether alkalies or lime are in connection with it during decay, and how long.

691. Table exhibiting the amount in pounds of carbon, &c., in the food and dung of two cows during fourteen days. *(Thompson.)*

	Brown Cow.			White Cow.		
	Grass.	Dung.	Consumption.	Grass.	Dung.	Consumption.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Carbon,	161¾	67	94¾	161¾	64	97¾
Hydrogen,	21	8	13	21	7¾	13¼
Nitrogen,	6½	2 7-10	3 8-10	6½	2½	4
Oxygen,	148	54½	93½	148	52	96
Ash,	13¾	14⅓	4 4-10	18¾	13¾	5
Water,	1070¾	902½	167½	1070¾	860	210¾
	1426¾	1049	377	1426¾	1000	426¾

(See also, *Liebig's Animal Chemistry*. Note 4.)

Or according to another estimate, a cow consuming 26.41 lbs. of grass daily, emits in shape of dung 11.13 lbs.; and consumes, in the support of its body, 15.28 lbs. 100 parts of fresh fallen cow-dung will afford 0.614 or five-eighths of a pound of pure ammonia, or about 2 lbs. 2 oz. of carbonate of ammonia *(sal volatile)* of the shops. *(S. L. Dana.)*

Analysis of 100 parts of cow-dung. *(Penot.)*

Water,	69.58
Bitter matter,	0.74
Sweet substance,	0.93
Chlorophyl,	0.28
Albumen,	0.63
Muriate of soda,	0.08
Sulphate of potash,	0.05
Sulphate of lime,	0.25
Carbonate of lime,	0.24
Phosphate of lime,	0.46
Carbonate of iron,	0.09
Woody fibre,	26.39
Silica,	0.14
Loss,	0.14

The amount of water, however, mentioned above, is too small. Boussingault gives the following comparative analysis:

	Fresh dung.		Dry dung.	
	Cow.	Horse.	Cow.	Horse.
Water,	90.60	75.31		
Nitrogen,	0.22	0.54	2.3	2.2
Saline matter,	1.13	4.02	12.0	16.3

So that in every 100 lbs, of fresh cow-dung, we have $\frac{1}{4}$ of a pound of nitrogen, and a little over one pound of salts.

692. Table exhibiting the food and water of a horse, consumed; and dung and urine, voided in 24 hours. *(Boussingault.)* *(See Liebig's Animal Chemistry.* Note 4.)

	Food.	Dung.	Consumed.
Carbon,	3938.0	1472.9	2465.1
Hydrogen,	446.5	191.3	255.2
Oxygen,	3209.2	1363.0	1846.2
Nitrogen,	139.4	115.4	24.
Salts and earthy matters,	672.2	684.5	+12.3

Analysis of horse-dung, in Rhode Island, *(Jackson.)* 500 grains, dried at a heat a little above that of boiling water, lost 357 grains of water. The dry mass weighing 143 grains was burned, and left 8.5 grains of ashes, of which 4.80 grains were soluble in dilute nitric acid, and 3.20 insoluble.

Water,	357
Vegetable fibre and animal matter,	135
Silica,	3.2
Phosphate of lime,	0.4
Carbonate of lime,	1.5
Phosphate of magnesia and soda,	2.9
	500.0

Horse-dung, in consequence of the smaller proportion of water, and more ammonia, ferments, or "heats," more rapidly than the solid excrement of the cow; the ammonia being evolved and lost; and in this mode it may be rapidly deteriorated.

693. The dung of sheep and of *fattening* hogs is richer in nitrogen than either of the above, and consequently ferments and acts more rapidly.

Boussingault found the following proportions:

	Sheep.		*Hogs.*	
	Recent	Dry	Recent	Dry
Water,	63.0	—	81	—
Nitrogen,	1.11	2.99	0.63	3.37
Ash	12.7		—	—

694. Dung of birds (Fowls, Pigeons, &c,) being mixed with urine, is still richer. In Belgium the dung yearly produced by 100 pigeons is valued at $5.00. Its immediate effect depends upon the quantity of soluble matter it contains, and this varies much according to its age, the mode in which it is preserved, &c. Thus Davy and Sprengel obtained respectively, of

	Recent,	Six months old.	After fermentation.
Soluble matter in Pigeons dung,	23 per cent	16 per cent	8 per cent.

The soluble matter consists of uric acid, urate, sulphate and

carbonate of ammonia, common salt and sulphate of potash;—the insoluble part of phosphate of lime, with a little phosphate of magnesia, &c. By fermentation it loses a portion of its ammonia. Every farmer should carefully clean his fowl-houses, at least once a week, and pack the dung in barrels with plaster, dry peat, earth, and a little salt &c; and in the spring sow it on his wheat at the rate of 300 cwt to the acre. If properly kept it differs but little from guano, for which $50 per ton is now paid at our shipping ports. In Michigan, 10 bushels more of wheat to the acre, might in many instances be thus obtained.

695. We give the following analyses of Guano, chiefly to show the composition of what has proved to be the most valuable manure in existence; and the nearer we can cause other manures to approach to it, the more perfect will our art become. It is merely the dung of salt-water birds preserved in the dry regions of the globe, chiefly on the coast of Peru. It has lately been stated, from actual measurement, that unless other deposites are discovered, and if the demand continues at the present height, the whole will be exhausted within 9 years. A patent has lately been granted in Great Britain for the preparation of an equivalent compound, at a lower price, from fish, fish offal, &c., and salts.

Analysis of 2 specimens of Peruvian Guano. (*Way.*)

Water,	12.57	13.67
Organic matter and Salts of ammonia,	33.67	52.97
Sand and Silica,	1.72	1.42
Phosphoric acid,	20.21	14,56
Sulphuric acid,	4.00	2.52
Lime,	16.49	10.38
Magnesia,	0.80	0.31
Oxide of iron,	0.22	0.73
Potash,	3.60	1.42
Soda,	4.15	none
Chloride of Potassium,	none	2.02

Chloride of Sodium,	2.57	none
Or the average of		per cent
Ammonia at		17.41
Phosphate of lime at		24.12
Potash at		3.50

These three being the elements chiefly demanded by plants, and in which the soil is apt to be deficient: in Guano, they are in the proper state of solubility and combination.

696. NIGHT SOIL, or human excrements, are extensively used in Belgium, Germany, China, and other countries; but the English and Americans appear to have an insuperable objection to manuring with these substances. A few years ago they were prepared in Great Britain and in the Ciy of New York, in a dry form devoid of smell, and called *Poudrette and Urate;* but they seem to have gone greatly out of use, probably on account of the means taken to render them less obnoxious dispelling the gases, so as to reduce the value of the manure below the cost of production. The excrement of men living on animal food is richer in nitrogen and phosphates than of those living on vegetables. *(See Liebig's Aanimal Chemistry, Note* 1.*)*

697. URINE. It is to the urine, that barn yard manure chiefly owes its value, both as regards nitrogen and salts; and yet in our Western States how few take any pains to save the liquids; or prevent their being afterwards washed out of the dung. Liebig denies that there is any available nitrogen in horse *dung;* and *practically*, it probably is so; so that with from 3600 to 4000 lbs. of fresh horse dung, corresponding to 100 lbs of dry dung, we place on the land from 2484 to 3000 lbs of water, of 730 to 900 lbs of vegetable matter and altered gall, and also from 100 to 270 of salt, and other inorganic substances, a portion of which only are soluble; while in urine, rotted with water, we apply a large quantity of nitrogen, as well as of the most valuable salts, and these in a dissolved state ready at once to feed the plant, and therefore requiring a very small quantity, as we have already shown respecting bones. The urine of all animals bears a very

strong chemical resemblance. We give the following table from *Sprengel* showing the composition of Cow's urine when fresh (A,); putrified alone (B,); and when putrified with water (C.)

	A	B	C
Urea,	4000	1000	600
Albumen,	10	—	—
Mucus,	190	40	30
Benzoin acid,	90	250	120
Lactic acid,	516	500	500
Carbonic acid,	5256	16	1533
Ammonia,	205	487	1622
Potash,	664	664	664
Soda,	554	554	554
Silica,	36	5	8
Alumina,	2	—	—
Oxide of iron,	4	1	—
Oxide of manganese,	1	—	—
Lime,	65	2	8
Magnesia,	36	22	30
Chlorine,	272	272	272
Sulphuric acid,	405	388	332
Phosphoric acid,	70	26	46
Acetic acid, (vinegar)	—	1	20
Sulphuretted hydrogen,	—	1	30
Insoluble earthy Phosphates and carbonates,	—	180	150
Water,	92,624	95,442	93,481
	100,000	100,000	10,0000

It will thus be understood how *fresh* urine may destroy vegetation, and yet prove beneficial when decomposed.

Urine of	Water in 1000 parts	Solid matter in 1000 parts.			Average quantity voided in 24 hours
		Organic.	Inorganic.	Total.	
Man,	930 to 970	22 to 52	8 to 18	30 to 70	3 lbs.
Horse,	886 to 940	27 to 79	33 to 45	60 to 124	3 ?
Cow,	880 to 930	50 to 70	20 to 47	70 to 120	40
Sheep,	930 to 960	28 to 50	12 to 20	40 to 70	?
Pig,	926 to 983	9 to 56	9 to 18	18 to 74	?

It is to the Urea which exists in urine in very much larger

quantity than in any other substance, that its beneficial effects are chiefly due.

Urea is a white salt-like substance, very soluble in water, consisting of—

	Per cent.
Carbon,	20.0
Hydrogen,	6.6
Nitrogen,	46.7
Oxygen,	26.7

Besides which, when the urine begins to ferment, this substance changes entirely into carbonate of ammonia. As this rapidly escapes into the air, the urine must be kept in covered vessels, and plaster, peat, sulphuric acid, &c., may be mixed with it; but burnt lime must not be brought into contact with it.

There are various modes of preserving the liquid manures of the barn yard, such as tanks, sawdust, &c.; but probably, in all respects, the best is the simple plan invented by Mr. Mechi, of England. This consists of a shallow, water-tight cellar under the stable, with a floor made of scantlings laid an inch and a half apart from each other, so that the dung adn urine fall below, and are preserved till carried to the field. It is of the utmost importance to the farmer to preserve this liquid; and if *one* must be lost, it ought to be the solid.

699. Good Barn Yard Manure, then, is a mixture of dung, urine, and straw, kept from the rain and sun, decomposed to a certain extent; and its value, per ton, must depend equally on the various proportions of these matters which it contains; the food of the animals; and the state of the decomposition, &c.

Analysis of barn yard manure, just previous to being applied, at New Castle-upon-Tyne, England. (*Richardson*:)

	Fresh.
Water,	64.96
Organic matter,	24.71
Inorganic salts,	10.32

	Dried at 212°.
Carbon,	37.40
Hydrogen,	5.27
Oxygen,	25.52
Nitrogen,	1.76
Ash,	30.05

Inorganic matter, 1. Portion soluble in water.

Potash, - - -	3.22	Sulphuric Acid, - -	3.27
Soda, - - -	2.73	Chlorine, - -	3.15
Lime, - - -	0.34	Silica, - - -	0.04
Magnesia, - -	0.26		

2. Portions soluble in muriatic acid only.

Silica, - - -	27.01	Carbonate of Magnesia, -	1.63
Phosphate of Lime, -	7.11	Sand, - - -	30.99
Phosphate of Magnesia, -	2.26	Carbon, - - -	0.83
Phosphate of Iron, -	4.68	Alkali and loss, -	3.14
Carbonate of Lime, -	9.34		

Thus, of 100 lbs. of barn yard manure, well made, well taken care of, and hauled on the field, 65 lbs. are pure water; of the remaining 35 lbs., 25 are inert carbonaceous matter, only serviceable as a source of carbonic acid, leaving only 10 per cent. of inorganic substances, and 0.6 of nitrogen, as true fertilizing matters. Of this 10 per cent. only 3 are of much value either as regards their commercial price or relative value. But the above manure is of extraordinary richness when compared with what we are in the habit of applying in the Western States. Ours is generally thrown out of the stables, every shower penetrating through it, and carrying into the next ditch whatever there may be soluble in water; then, through spring and summer, the heat of the sun and fermentation drives off all gases as formed; and when, at much toil and expense, we apply it, we find nothing which can feed a plant or assist it to grow. The "black water" found round manure heaps, where there happens to be a hole in the ground, is sufficient proof of this. The peat and marl of our marshes are much more valuable than *such* dung.

As this a point of great practical and economical importance, the teacher ought to impress it especially on the minds of his pupils, and may exhibit the effect of water and heat on fresh manure before them.

We strongly recommend all farmers who take the trouble to haul their manure on to their soil, to save it either on Mr. Mechi's plan, or to have a cheap shed near the door of the stable into which it can be pitched, taking care to use sufficient straw, sawdust, peat, &c., to absorb all the liquids. One load of such dung is proved to be

equal to at least eight that have been exposed. The best mode of saving sheep manure is to keep the sheep under sheds, giving sufficient straw to keep them clean. Not only is much manure thus saved, but less food is consumed, and the sheep are much more profitable. (*See Farmer's Companion and Horticulural Gazette*, VOL. 1, P. 6, 64.)

700. In America, the European mode of making *composts* of barn yard manures and other substances is not much employed. It is not only a greater expense of manual labor, and lower value of produce which forbid it, but there are serious reasons for believing that with our very hot summer climate, and comparative want of showers, composts will not act as effectively with us as they do in the Eastern Hemisphere. The subject, however, does not appear to have been yet tested by experiment, and we can only speak theoretically.

There are many other sources of animal manures enjoyed in various parts of the world, but which at present are of no practical interest to Western farmers.

701. MINERAL MANURES.

By this term we mean all substances of an inorganic nature, all of which are derived, either directly or indirectly, from the soil, such as wood and coal ashes, plaster, &c.

WOOD ASHES. These are the remains of trees, after the organic or vegetable matter has been consumed (driven off in the shape of gas,) by fire; and consequently, while they all bear a general resemblance, they differ much in the relative proportion of the constituents, according to the trees and soils from which they are derived. As manures they have a two fold action; *(a,)* they supply to the plant the inorganic constituents which it requires; *(b,)* they act chemically as solvents upon other insoluble salts already in the soil; or they neutralize acids, &c.

702. When we have burnt a tree and collected the ashes we find that they consist of two portions, those that are soluble in water and those that are insoluble. The average quantity of ashes from 100 parts of dry oak, beech, birch, &c., is 2.87. 100 parts of such ashes afford 13.57 parts soluble; 86.43 parts insoluble, the latter being left behind at our ash works, while the soluble have been boiled down and exported as potash. Pine

wood (dry,) affords only 0.83 in 100 parts of ashes; of which 50 are soluble, 50 insoluble. Wheat straw yields 4.40 in 100 parts, 19 per cent. being soluble, 81 insoluble.

Composition of the ashes of hard wood, (oak, beech, birch, &c., *(A)*; of Pine, *(Pinus abies,) (B)*; and of wheat straw, *(C)*. *(Dana.)*

100 parts of soluble contain	A,	B.	C.
Carbonic Acid,	22.70	13.50	——
Sulphuric Acid,	6.43	6.90	0.2
Muriatic Acid,	1.82	——	13.0
Silex,	95	2.00	35.6
Potash and Soda,	67.96	69.70	50.0
Water,		7.90	

100 parts of the insoluble contain,	A.	B.	C.
Carbonic Acid,	35.80	21.50	
Phosphoric Acid,	3.40	1.80	1.20
Silex,	4.25	13.00	75.00
Oxide of Iron,	0.52	22.30	2.50
Oxide of Manganese,	2 15	5.50	
Magnesia,	3.55	8.70	
Lime,	35.80	27.20	5.80
Charcoal,			15.50

The following gives a comparative view of the entire ashes of the oak *(A,)*; elm *(B,)*; Beech *(C,)*; and fir tree *(pinus sylvestris,)*; *(D,)*; analysed in Europe. *(Johnston.)*

	A.	B.	C.	D.
Potash,	8.43	21.92	15.83	——
Soda,	5.65	13.72	2.88	9 97
Lime,	75.45	47.80	63.33	46.15
Magnesia,	4.49	7.71	11.29	13.46
Oxide of Iron,	0.57	0.38	0.79	3·26
Phosphoric Acid,	3.46	3.62	3.07	4.49
Sulphuric Acid,	1.16	1.28	1.35	3.03
Chlorine,	0.01	——	0.14	0.71
Silica,	0.78	307	1.32	8.38
Percentage of ash in the dry hard wood,				0.143

It is thus obvious that, by leaching, little else is removed than

potash, soda, and sulphuric acid, (the carbonic acid being a product of combustion, and of no intrinsic value); and when ashes are thus separated on a large scale, a notable quantity of the alkalies remains behind. Though the refuse is not *immediately* soluble, it will become available to plants in the soil by chemical action, and the power which roots appear to possess of decomposing mineral matter; while such alkalies as remain will act on the silica, and form soluble silicates for grass and the stalks of grain.

In leaching, more or less lime is always added for the purpose of depriving the potash of its carbon, and rendering it caustic, so that the common leached ashes are richer in lime than before the process commences. According to Dana, a bushel of good ashes contains about 5½ pounds of real potash. In leaching ashes, generally about one peck of lime is added to each bushel of ashes, and as it loses no bulk during the operation, a *cord* of leached ashes contains about the following proportions —allowing an average of 4½ lbs. per bushel to be leached out:—

	lbs.
Phosphoric acid,	117
Silex,	146
Oxide of iron,	17
Oxide of manganese,	51
Magnesia,	119
Carbonate of lime, including that added in leaching,	3072
Potash combined with silica,	50

Spent ashes therefore belong to the class of carbonates; and to the farmer are worth very nearly as much as the unleached.

In nearly the whole range of soils, ashes are beneficial to cultivated plants; but much more so on sandy and gravelly lands than on clay, which being chiefly formed of granite rocks naturally contain potash. We have also seen, in the analyses of plants, that certain genera, such as turnips, carrots, potatoes, beets, &c., contain a very large amount of the alka-

lies; to such therefore ashes are found to be an essential manure. But the *immediate* benefit of such an application is most perceptible upon leguminous plants, such as clover, peas, beans, &c. Applied to grass land, as a top dressing, it roots out the moss, and promotes the growth of white clover, where it is indigenous to the soil. On Red clover, it will act more certainly in connection with plaster. If applied in *large* doses to poor thin soils it is believed to act injuriously by causing a rapid disappearance of the organic matter, but this may be prevented by the use of peat, barn-yard manures, &c., at the same time.

In connection with all wood-ashes is a large quantity of charcoal, and imperfectly burned carbonaceous matter, which also add to the value of the manure.

Unleached ashes act at once, most rapidly and powerfully; leached ashes act more slowly, but continue to act for many years after being applied. In the large heaps of such ashes, as everywhere accumulate in the west around the asheries, we neglect a most useful source of fertility; and where they have thus lain for a length of time, they are probably, to a considerable extent, again rendered soluble. Their effect on the *mechanical* condition of the soil is also worthy of notice. They render sands more compact and retentive of water, while they separate and render friable, heavy clays.

In practice, they should always be placed *in* the soil, where the roots can come in contact with them.

It is a general custom to apply ashes to corn, on the *surface* of the ground, but in this way the plant can receive no benefit except from the little that is soluble and is carried down by rain; but placed in the ground previous to planting, the roots and chemical action will afford many elements not available in the other way. The only advantage of placing ashes on the surface is the protecting of the plant against grubs. The seed, however, should not come in immediate contact with the ashes.

Prof. Way has lately ascertained that all clay soils contain a double silicate of alumina and one of the alkalies or alkaline earths, as :—

Soda,		Lime,
Potash,		Magnesia,
	Ammonia.	

which is slowly soluble, but sufficiently so to supply what plants require ; and that these silicates, without exception, are capable of absorbing and retaining ammonia; and, what is still more important, some of them have the faculty of abstracting ammonia from the air. " Whenever a salt of ammonia or potash reaches the soil, and gets distributed through it, a change occurs—a double silicate of alumina and ammonia is formed, and the salt which was added no longer exists there. The ammonia or potash henceforth exists in the soil only in the form of silicate, and is presented to the roots of a plant only in that form, or in the form of carbonate derived from it by the action of carbonic acid in the soil. And inasmuch as all average soils possess this property of conversion in more than the degree necessary for the quantity of manure which reaches them, the inference is obvious and incontestable, that nature has given to the soil this power for the specific purpose of preparing the food of plants, and we then have the soil occupying a place intermediate between that of mere dead matter, and the living organism of plants." We can only thus slightly mention this most important and beautiful discovery ; and refer the reader to Prof. Way's own writings in the *Jour. of Royal Agricul. Socy. of England*, vol. xiii, &c.

703. Lime is everywhere an essential of a fertile soil, and in Great Britain is more extensively used than any other mineral substance. It is applied in a variety of forms, as *(a,)* carbonate of lime—lime rock—(44 lbs. of carbonic acid and 51 lbs. of lime;) *(b,)* the same lime rock burned, and the carbonic acid driven off, when it becomes caustic, but again absorbs carbonic acid and moisture rapidly from the air when it again returns to a carbonate, or is "slaked;" *(c,)* Gypsum, Plaster, *Sulphate of lime.* *(d,)* Phosphate of lime, as in bones, &c., of which we have already spoken. *(e,)* Silicate of lime, existing in many rocks and earths; *(f,)* Marls; *(g,)* Chalk, which is another form of carbonate of lime, chiefly found in England; *(h,)* Magnesian limestone, the base of which is lime, with a

varying proportion of magnesia. Of these, only common lime, plaster and marl are of present interest to us in this part of the country.

Lime rocks are rarely pure, and they vary much in their exact composition. It is believed that those of Michigan have not yet been analyzed. The following are specimens from Seneca county, N. Y., examined by Mr. Delafield,

	NO. 1.	NO. 2.	NO. 3.	NO. 4.
Insoluble sand and clay,	6.7	15.0	4.0	78.0
Alumina and peroxide of iron,	1.4	23.0	26.0	9.0
Carbonate of lime,	90.0	53.5	60.0	11.0
Magnesia,	1.5	2.8	5.5	2.0
Oxide of manganese,	none,	none,	1.0	
Soluble saline matter,	1.4	1.2	2.4	
Phosphoric acid,	trace,	trace,	0.1	

(*Trans. of N. Y. Agricul. Socy.*, vol. x, p. 611.)

The following are analyses of English lime rocks made by Prof. Johnston, in their unburned and burned states:—

UNBURNED.	NO. 1.	NO. 2.
Carbonate of lime,	94.86	95.89
Sulphate of lime,	0.23	0.32
Carbonate of magnesia,	1.26	0.54
Alumina and oxide of iron,	0.73	1.20
Phosphate of lime,	?	?
Silica,	2.92	2.05
BURNED.	NO. 1.	NO. 2.
Lime,	89.93	88.85
Magnesia,	1.02	0.43
Sulphuric acid,	0.22	0.30
Phosphoric acid,	?	?
Alumina and oxide of iron,	1.23	1.98
Silicate in the state of silicate,	4.92	3.39
Carbonic acid and moisture,	2.68	5.05

(*Johnston on the use of lime in Agriculture*, p. 243.)

We shall shortly mention the effect of burned and slaked lime upon the land.

1. Mechanical; it opens and renders free, stiff clays, and con-

solidates sands. 2. Chemical. *(a,)* increases the fertility of all soils in which it does not already abound; and especially of tenacious, moist soils and those containing much inert vegetable matter; *(b,)* it improves the *quality* of the crop; *(c,)* it increases the effects of manure, calls into action that which is dormant, and less manures needs afterwards be applied; *(d,)* alters the natural produce of the land by killing some plants and favoring the growth of others—it kills moss and sour grasses and brings up sweet and tender herbage with clovers—wheat has a thinner skin, and yields more flour—runs less to straw—peas and beans are of better quality, and so with most plants; *(e,)* it hastens the maturity of the crop; *(f,)* it renders the whole country more healthy, and plants less subject to diseases.

Lime, indeed, can scarcely be applied judiciously to any soil without benefit; but it requires care and experience acting as it does with a varying effect under different circumstances.

The quantity of lime which ought to be added to a soil is of course a question of experiment and practice. Theoretically 3 per cent of lime *(finely disintegrated)* at least, ought to be present in a soil which contains an ordinary proportion of vegetable matter and of the other food of plants. In order to add 1 per cent of lime to the land, the quantity to be laid on will depend upon the depth. The following table shows the number of tons of burned lime as it comes from the kiln, which will give one per cent of lime to soils, respectively 3, 6, 9, and 12 inches in depth.

If the depth of the soil be	12 ins.	9 ins.	6 ins.	3 ins.
Tons of burned lime,	*per cent*	*per cent*	*per cent*	*per cent*
16 tons give - -	1	1½	2	4
12 " - - -	¾	1	1½	3
8 " - -	½	¾	1	2
4 " - - -	¼	⅜	½	1

Quantity of quicklime applied per Imperial acre in different localities:

	Bush.		Years.		Bush. a year.	When applied.
Roxburgh,	200	every	19	or	$10\frac{1}{2}$	to the fallow
Ayr,	40	"	5	or	8	do., or lea
Carse of Stirling	54	"	6	or	9	do
South Durham,	90	"	12	or	$8\frac{1}{2}$	do
Worcester,	70	"	6 or 8	or	10	before grasses & tares.
Flanders,	$\begin{cases}50\\12\end{cases}$	" "	$\left.\begin{matrix}12\\3\end{matrix}\right\}$	or	4	

Or at the average of 8 or 10 bushels a year per acre.

Lime is found, in some of its shapes, over a large portion of the United States; but so far, its application as burnt lime has been much neglected. For further information we refer the reader to *Prof. Johnston's Essay on the use of lime in agriculture*, 12 *mo*, *pp*. 259, *Edinburgh*, 1849.

704. GYPSUM OR PLASTER is a *Sulphate of lime.* 100 lbs of common gypsum consist of 46 lbs of sulphuric acid, 33 lbs of lime, and 21 lbs of water. When it is heated to redness this water is driven off, and the gypsum is very easily reduced to an exceedingly fine powder. In this form it is used by masons. It dissolves in 500 times its weight of pure water, or 50 gallons will dissolve one pound. Thus it is often found in spring water, and in streams which pass through a soil in which gypsum exists. In solution with water it is decomposed when mixed with fermenting animal or vegetable matter.

Gypsum acts very differently on different soils and in different localities; at times producing no visible effect whatever; and at others, becoming almost a necessary of profitable cultivation.

The theory of its beneficial action has long been a subject of dispute. The most probable solution is, that to a small extent it supplies lime and sulphuric acid to the plant, but is chiefly useful by the power it possesses of solidifying and retaining the ammonical gases of air and earth.

Benjamin Franklin first introduced it from France into the United States. It was afterwards imported from Nova Scotia; and as New York, and the other Western States were settled, it was discovered in abundance. Ohio and Michigan possess large beds of it in various localities. It is quarried, and ground in

mills; but is supposed to differ in quality, some mines having a higher reputation than others, probably in consequence of greater purity. That used by masons is said to be ground from selected specimens.

It were interesting to try quick lime along side of plaster, so as to ascertain the relative effect and profit of each. At present, plaster in Michigan is expensive, costing $7.00 loose or $9.00 in barrels per ton at the mill; and most that is used is carried by land either from Detroit or Grand Rapids; while there are few farms in the interior of the State which cannot procure excellent marl at little more expense than digging. The late Dr. Houghton expressed the opinion that upon our sandy lands, the shell marls, even without burning, would prove quite as effective. Of the quantity consumed in this State we have no correct statistics. We find that during the year ending June 1853, the Central Railroad carried 2,613 tons; and allowing as much more for the Southern Railroad, and for private conveyance, we have a total of 5226 tons averaging $10 per ton delivered on the farm, which makes a total of $52,260 per annum for this one manure. It is very important that our marls and peats should be more fully investigated and their effects carefully tried.

Prof. Johnston states that when mixed with common salt, the action of gypsum upon clovers, beans, peas, &c., appears to be greatly increased.

W. Alexander, of Ballochmyle, Scotland, dressed an apparently worthlest crop of young beans with a mixture of 2 cwt. of gypsum, and one of common salt per acre. The effect was almost marvelous, and instead of a bad crop, his beans were the admiration of the country. He found a sensible effect produced by this mixture even after the beans were in flower.

Plaster acts as a stimulant, and its tendency is to impoverish the soil unless organic and other manures are liberally added.

705. Marl properly means an earthy mixture containing not less than 20 per cent of carbonate of lime. If the proportion of lime be less than this, the mixture is rather a marly clay, containing potash or silica in place of lime, as in the Green-sand marls of New Jersey, and Silicious marls of Massachusetts. *(See*

§ 117, 118, 119, 120, *p.* 37.) Of the true marls, there are many varieties, differing both in composition and external character; and consequently in value.

The following are analyses of marls in Seneca Co., N. Y.

	No. 1,	No. 2,	No. 3.
Moisture, - -	4.50	1.0	3.48
Organic matter, -	8.50	4.20	1.65
Insoluble sand, -	6.60	6.0	5.0
Carbonate of lime, -	77.10	83.33	83.35
Magnesia, - -	2.10	2.16	4.0
Phosphoric acid, Alumina, } - -	1.20	2.8	0.86 2.00
Common Salt, -	—	—	0.20
Sulphate of lime, -	—	50	—
Sulphuric acid, -	—	—	0.46

The lime marls appear to be formed in two modes; *(a,)* by the deposite of lime brought to the surface by springs; *(b,)* by the accumulation of shells, and minute forms of animal life, or *Infusoria*, often microscopic, with calcareous coverings. "Some of these are so minute, that a cubic inch of stone has been calculated to contain the remains of 41 thousand millions of them—and yet deposites composed almost entirely of such remains have been met with of 20 and 30 feet in thickness. How very striking is it to find the united labors of these invisible creatures capable of producing such extraordinary effects! How very little we really know of what is going on around us!" *(Johnston.)*

The marls of Michigan are believed to consist of both these kinds, but especially of the latter. We believe they have never yet been analyzed, but will probably be found rich in phosphoric acid and ammonia. Mr. Delafield states of the New York marls above mentioned, that the *poorest* will afford 25 lbs of phosphoric acid to every ton of dry and weathered marl. This is equal to 45 lbs of phosphate of lime, a quantity found in 80 lbs of bone dust, and equal also to what a grazing cow annu-

ally takes from the land. The best Michigan marls will probably be found much richer than the above—and here is the very substance in which our oldest wheat lands are beginning to be deficient, *(See Genesee Farmer, August,* 1853,*)* and yet it is allowed to lie neglected and despised in almost every marsh and lake. Marls may be applied in two modes, *(a,)* burned as lime, in which respect they do not much differ in effect from the best agricultural lime rocks; *(b,)* in the natural state, but dried so as to powder. Like lime they produce a mechanical and chemical effect; the first differing with the soils and the character of the marl. The chemical effect consists in actually rendering the soil productive of larger crops. The exact mode of acting does not appear to be well understood. The *observed* effects of marl and shell sand, in so far as they are chemical, are chiefly the following:—They alter the nature and quality of the grasses when applied to pasture; they cover even the undrained bog, with a short rich grass—they extirpate coarse grasses and moss, and the weeds which infest unlimed wheat fields; they increase the quality and enable the land to grow a better quantity of wheat; they manifest a continued action for many years after they have been applied; like the purer limes, they act more energetically if aided by the occasional addition of other manure; and like them they finally exhaust a soil from which successive crops are reaped, without the requisite return of decaying animal or vegetable matter. *(Johnston.)*

In practice it is probably best to dig the marl, and leave it to dry and disintegrate for some months before applying. One ton and upwards may be applied to the acre, and plowed in *shallow* at the last plowing, or worked in with the cultivator. To act effectually, lime must be kept near the surface, and its constant effort is to sink below the reach of roots.

706. SALT is chemically composed of the metal *sodium*, and the gas *chlorine*, *chloride of sodium*, or called by the older chemists *muriate of soda*. It is procured by evaporating the

water of the sea or salt springs, and is rarely found in commerce perfectly pure; salts of lime and magnesia being mixed with it.

Salt is found in nearly all soils; in the ashes of all plants; and is necessary for animal life. It has been used in all ages and countries as a manure, and acts not only as a feeder of plants, but chemically as a solvent, and in this latter regard appears to be most efficient. In some soils it strengthens the straw, but it acts variously in different localities. *Theoretically*, it ought to prove very efficient in our Western States. Mixed with plaster it is said greatly to improve the latter. It must be used with care, and not applied *directly* to the plants. In dry climates, where seasonable rains seldom fall, salt will rarely do anything but injury. Root crops, and of those, beets, appear to be the most benefitted by salt. From one to ten bushels may be applied to the acre, sown broadcast and harrowed in, a few days before the seed is sown. In New York, three bushels to the acre have been found effective in destroying grubs, cutworms, &c.

707. Mud, Muck. This substance is found in great abundance in many ponds, marshes, &c., and in some localities it has been applied with great success as a manure. It necessarily varies much in its composition. Mr. Dana analyzed two specimens in Massachusetts, and he found them to consist of:—

		No. 1.	No. 2.
Soluble Geine,	Organic.	5.10	8.10
Insoluble Geine,		8.90	6.50
Salts and Silicates,		86. 0	84.40

A cord of No. 1 weighed when dug 6117 lbs., and contained solid matter, 3495 lbs.; composed of geine, 495 lbs.; of silicates and salts, 3005 lbs. The salts of lime were 2½ per cent.; from which we judge that it would prove a vaulable manure.

Prof. Johnston examined a black mud from Leith Docks,

which was carted away by the farmers. He found a considerable quantity of animal matter, with much finely divided silica, which were found under the microscope to be infusoria.

Many mucks will probably be found to contain phosphoric acid, ammonia, vegetable matter, sulphur, and salts of lime and potash, and if so they are important to the farmer; but in our present state of ignorance regarding them, we can only recommend careful trials. We believe that, in practice, they are usually left exposed to the air, after digging, till dry and disintegrated; and if dug in the fall, so as to be frozen, they are found to be inproved.

708. III. VEGETABLE MANURES.

These are practically of two classes; *(a.)* such as are grown for the purpose of being plowed in; *(b,)* and those which are collected from other sources, and applied as are ordinary manures, *e. g.* peat, leaves, &c. In the West, the first are employed in the shape of buckwheat, clover, and sometimes rye; and in other countries several plants are used for the same purpose; being turned under immediately before flowering. Such plants as collect their food chiefly from the air by the leaves, and contain much carbon, or those whose roots pierce deep into the subsoil, are preferred. Their value is owing to the elements which they supply directly to the next crop; and they are estimated according to the amount of nitrogen, carbon, and inorganic matter which they contain. In soils deficient in organic matter, such manuring is often very profitable when properly applied. The mechanical tendency of such applications is, also, to render stiff soils more friable.

In the second division a great variety of substances have been used, as straw, chaff, bran, rape cake, sawdust, malt-dust, &c.; but, in this country, PEAT promises to prove the most important. Peat is a partially decayed moss or *sphagnum*, and is a real coal in an imperfect state. It is found in marshes and wet

places, and is sufficiently abundant throughout Michigan and the other Western States. Like all other similar substances, it is subject to many variations in its composition. Some specimens contain a large proportion of ammonia, and they all appear to be rich in salts and carbon.

Analysis of peat from Paisley Moss, Scotland, viz: an upper peat, (A;) an under peat of the same bed, (B;) and of the Dutch ashes, formed of peat, (B.) *(Johnston.)*

	A.	B.	C.
Organic matter, (charred peat,)	54.12	3.02	25.77
Sulphates and carbonates of potash, soda, and magnesia, soluble in water,	6.57	5.1	2.78
Alumina, soluble in acids,	2.99	2.48	11.19
Oxide of iron,	4.61	18.66	
Gypsum,	10.49	21.23	16.35
Phosphate of lime,	0.90	0.40	1.24
Carbonate of lime,	8,54	3.50	1.21
Carbonate of magnesia,			3.39
Insoluble siliceous matter,	10.88	43.91	37.24
	99.10	98.36	99.17

Analysis of 10 varieties of Peat from Massachusetts. *(Dana.)*

Locality.	Saluble Geine.	Insoluble Geine.	Total Geine.	Salts & Silicates.
1. Dracut,	14.0	72.0	86.0	14.00
2. Sunderland,	26.0	56 60	85 60	14.40
3. Westborough,	48.80	43.60	92.40	7.60
4. Hadley,	34.0	60.0	94.0	6.0
5. Northampton,	38.30	44.15	82 45	17.55
6. "	32.0	54.90	86.90	13.10
7. "	12.0	60.85	72.85	27.15
8. "	10.0	49.45	59.45	40.55
9. "	33.0	59.0	92.0	8.00
10. "	46.0	46.80	92.80	7.20
Average,	29.41	55.03	84.44	15.55

By the word "Geine" this writer means the *vegetable matter of soils*, also called *Humus, Ulmin*, &c., and represented by the symbol C 40,

H 16, O 14, with, occasionally, an addition of ammonia. The term is now rarely used in agriculture.

All Peat shrinks by drying, and when perfectly dried at 240 ° F. loses from 73 to 97 per cent of water. When allowed to dry in the air, it still contains about two-thirds of its weight of water, and rapidly re-absorbs moisture. It shrinks from two-thirds to three-fourths of its bulk. Taking these data, 100 parts of fresh dug peat, of average quality, contain:—(*Dana.*)

Water,	85.0
Salts of lime,	0.50
Silicates,	0.50
Geine,	14.0

Owing to the difficulty of rendering Peat soluble, it has not been used in agriculture to the extent it deserves, in its natural state. It is frequently burned (or rather *charred*,) and the ashes are applied with good effect at the rate of from 50 bushels to two tons per acre.

Prof. Norton, says: "They usually contain from 5 to 6 per cent of potash and soda, considerable quantities of lime, magnesia, iron, &c., being therefore worth about as much as the poorer kinds of wood-ashes. In wet land, where varieties of peat abound, which are only decomposed with great difficulty, it is sometimes advisable to burn them on a large scale for the purpose of obtaining the ash as manure. Heaps are made at convenient distances directly upon the surface of the bog, and the fire started by means of a little dry peat in the centre of each heap; as it burns through to the outside, fresh peat is dug up and thrown on, and so the process may be kept up as long as desirable. It is to be observed as to all varieties of ashes, that their value is greatly impaired by exposure to the weather." But the best mode of using peat is to lay it in cattle stables, and to mix it with decomposing animal manures; when it will, if sufficiently dried, not only absorb the liquids, but itself undergo fermentation. According to Mr. Phinney,

of Lexington, Mass., a cord of fresh dung converts twice its bulk of peat into a manure of equal value to itself—that is, a cord of clear stable dung, composted with two of peat, forms a manure of equal value to three cords of green dung.

Mr. S. L. Dana, of Lowell, Mass., wrote a book, a few years since, for the purpose of showing that peat mixed with an alkali, in all respects resembles, and, as a manure, is equivalent in effect to cow dung. The cost per cord, at that time, he estimates as :—

1 Cord peat and digging, - - -			\$1.50
92 lbs. potash at 6 cents,	\$5.52	average of alkalies,	3.65
Or 61 lbs. soda ash at 4 cents,	2.44		
Or 24 bush common wood-ashes at 12½ cents, - - -	3.00		
	3)10.96		
	\$3.65	Per cord....	\$5.15

Were they really good hard-wood-ashes, about 16 bushels would be sufficient, but an excess is allowed to compensate for variation. At that period, clear cow dung was purchased by the Print works at an average cost of 17 4-5 cents per bushel, or \$17.45 cents per cord, at times even higher.

We must he e complete our very imperfect remarks on manures, as the subject is sufficiently extensive to fill a much larger volume than this. The teacher will find all that he can require in the *American Muck Book*, by D. J. Browne, 12 mo. pp. 429, published by C. M. Saxton, New York, 1852.

For the sake of convenience, however, we add a list of the articles used in various countries as manures, designating with an asterisk (*) such as can probably be of service in the United States.

I. Animal Manures.

Blood.*
Flesh.*
(Dried flesh, from South America.)
Bones.*
Skin.
Wool.
Hair.*
Feathers.
Woollen rags,* (England.)
——— Mill refuse,* (England.)
Fish, (New England, &c.)
Blubber, and other fish refuse.*
Refuse of Lard-Boilers,* (Cincinnati, &c.) The whole hog is boiled by a heavy pressure of steam, and all, but the oil. left as a dry power.)
Other refuse of Pork Packers.*
Bone Black, or animal charcoal, from Sugar Refineries.*
Refuse of Bone and Ivory Turners, &c.
Dung of Horses.*
" Cows.*
" Sheep.*

Dung of Hogs.*
" Men.*
(Pudrette.)*
Droppings of Birds.*
Guano.*
Urine of all kinds.*
(Urate.)*
Shells, (marine and fresh.*)
Infusoria in muck.*
Coral sand*?
Scutch, (Glue maker's refuse.)*
Refuse from Tanneries.*

II. Mineral.

Carbonate of Ammonia.
Nitrate of Ammonia.
Muriate of Ammonia.
Sulphate of Ammonia.
Water from Gas works.*
Lime from Gas works.*
Coal Tar.
Wood ashes, (unleached.)*
do (leached.)*
Coal ashes, (Anthracite.)*
do (Bituminous.)*
Ashes of Sea-weed, (Kelp, or Barilla.)
Soap maker's waste, (Soda.)*
Bitterns, (Refuse of Salt works.)*
Burnt clay.*
Rubbish of old buildings.*
Coprolites, (a mineral phosphate.)
Apatite, (a mineral phosphate.)*
Lime, (carbonate of.)*
Burnt lime.*
Sulphate of lime, (plaster.)*
Phosphate of lime.
Silicate of lime.
Nitrate of lime.
Marls, (Calcareous.)*
Potash.
Nitrate of Potash, (Saltpetre.)
Potash Marls, (Greensand.)*
Soda.
Chloride of sodium, (common salt)*
Nitrate of soda, (Peruvian Saltpetre.)
Sulphate of soda, (Glauber salts.)
Magnesia.
Sulphate of magnesia, (Epsom salts.)
Silica, (Sand.)*
Sulphuric acid.
Clay, or sand, of Granite, Greenstone, Serpentine, and Basalt Rocks.*

III. Vegetable Manures.

Straw.*
Chaff.*
Leaves of plants and trees.*
Spoiled hay.*
Saw-dust,*
Charcoal *
Vegetable matter, charred.*
Spent Tan, (appears to act specifically on strawberries.)*
Apple Pomace.*
Weeds *
Cotton Refuse.*
do Seeds.*
Stems of Flax.*
Refuse of water of flax mills.*
Bran.
Rape Cake.
Rape Dust.
Cake of Linseed.
do Poppy seed.
do Cocoa nut.
Refuse of other oil-seeds.
Peat.*
Sea-weed,*
Tops & leaves of cultivated plants.*
Soot.*

To plow in—Green Manures.

Red Clover.*
Buckwheat.*
Rye.*
Corn, (Maize.)*
Turnips.
White Lupines.
Vetch or Tares.
Rape.
White Mustard.
Vine twigs, (for Vineyards.)*
Malt-dust.
Refuse of Starch manufactories.*

There are a few other expensive salts occasionally used in very high farming, but they are scarcely worth mentioning. (See *Johnston's Experimental Agriculture*, 1849.)

CHAPTER XXIII.

PLOWING.

709. Plowing is merely a means resorted to for stirring up the soil, and rendering it friable in order that it may receive the seed. Digging was probably the original mode of performing this operation, but as this is very laborious, although very effective, some sort of plow appears to have been invented as soon as oxen or horses were employed in agriculture. The history of the plow is the history of the art; for so intimately are good crops dependent upon good plowing. that just in proportion as this implement has been improved so has the product of the earth increased in quantity. But it is only of late years that this all important implement has been formed on *true* mechanical principles; and, with the exception of Great Britain and America, nearly all the world still cling to the use of antiquated and inefficient forms; nor can it yet be said that either the plow or the mode of using it are fully understood. The English and Americans form and use the plow on different principles, the first endeavoring to lay an unbroken furrow, the latter trying to break or pulverize the soil in the operation; while the proper depth of plowing in different classes of soils is very little understood by practical men. Notwithstanding the great skill with which the best American plows are made, there is still a wide field of improvement open in both these respects. Within a very few years, many efforts have been made to plow by steam, or by horse power, indirectly applied; and a Canadian is at this moment perfecting a machine in England; while there is one

in successful operation in that country which may be worked either by steam or horse power. This is not strictly *plowing*, in the usual sense of the word, but turning up the soil by rotary cutters. Should such machines become generally available they will probably revolutionize agriculture, as the introduction of the Spinning Jenny &c. revolutionized the manufacture of Cotton and Woolen cloths; since it will be impossible for small farmers, working on the old plan, to compete with large capitalists, with extensive farms, doing all their work by steam and other machinery. As however, the improvements introduced into manufactories have not only benefitted the world in general, but supplied work for a very much larger number of laborers, so may we expect this revolution in art to produce the same effect in agriculture.

710. Till within a century, all plows were made of wood with wrought iron plates &c, nailed on, for the land-side, mould-board, and point. In Great Britain, they were generally prepared with one or two wheels at the end of the plow-beam, as they still are in France and Germany, and were drawn by 4 to 8 horses; or by a pair of horses with the addition of four, and sometimes of six oxen, with one man to hold, and two to drive. About 1763, James Small, of the county of Berwick, Scotland, a manufacturer of Agricultural implements, turned his attention to the improvement of plows. In experimenting, he made the mould-board of *soft-wood*, by means of which it soon appeared where the pressure was the most severe, and where there was the greatest friction. He likewise applied true mechanical principles to the subject; introduced cast iron in place of wood; and so lightened the draft that two horses were quite as efficient as the heavy teams previously employed. This appears to have been the first invention of the light and elegant cast-iron *swing* plows which are now every where in use in this country. (Sir John Sinclair, in his *Account of the systems of husbandry adopted in Scotland*, 1812, gives the full history of this invention.) This introduc-

tion of an improved plow has not only had a most favorable bearing upon agriculture in every respect, by reducing the cost of working the soil, and doing the work in a much better manner, but it is very doubtful, whether a very large portion of America could yet have been settled, if so many animals and men had been requisite to perform the operation. Plows are made so as to be adapted to every sort of soil and work, and are arranged upon well known and accurately ascertained principles. These principles every farmer should understand; but as this knowledge presupposes an acquaintance with mathematics and mechanics we cannot enter upon it here.

711. The object of the plowman is so to turn over the soil as to render it the best adapted for the growth of plants with the least expenditure of labor and time. If the soil is so turned as merely to be reversed, lying, as it were, in long *ribbons*, friability is not attained, but must be produced by subsequent operations, with the harrow, cultivator, &c. If the soil is so broken, that part is reversed, and part is not, weeds are tempted to grow and the crop will be uneven. If there are inequalities, and deep holes, some seeds will be buried too deeply, others will be too shallow. The best plowmen, therefore, endeavor, while they separate the soil, entirely to reverse it, to lay the furrows perfectly even on the surface, and to plow as deeply, and as great a width at the same time as possible. In narrow furrows, the soil will be rendered friable most effectually, but time will be lost.

Depth is of great importance in successful agriculture, under nearly all circumstances. There may be subsoils of such a character that it would be injudicious at once to turn up much of them; but by annually plowing an inch or so deeper, by degrees great depth is attained without injury. Deep plowing acts in the same manner as thorough draining, but to a less extent. It gives the roots of plants a larger field from which to gather their food; it allows surface water to escape; atmospheric manures to be collected instead of running off; and it affords

a more equal and probably a higher temperature and greater command of moisture. A field plowed three or four inches deep is easily exhausted; while such manures as are applied, soon escape beneath the reach of the roots; and, in many soils, in process of time, the plow passing at one equal and shallow depth forms an artificial and impervious *hard-pan.* According to Mr. Delafield in 1850, in Seneca county New York, "The evidence of every successive year, has clearly manifested the economy and profit of deep tillage; the mechanical operations on the soil require less force and labor; less seed is necessary; and all manures produce their full effect. Many of the best informed farmers are firm in the opinion that deep plowing and subsoil plowing are more effective on wheat soils when a judicious system of drainage has been adopted; for though deep tillage by the plow allows the roots of plants to seek their food at a greater depth from the surface, yet they will extend themselves (in some soils,) to the cold influences of retained waters, where drains do not exist, and be deprived of that full measure of health and vigor which the principle of deep tillage is intended to afford."

The *Jointer Plow,* invented in Michigan, is forcing its way into very general use. It is a miniature or small plow, which can be attached and detached from the beam of any other plow at pleasure, and is placed a short distance in advance of the main plow. It turns over 2 to 4 inches of the soil which is buried deeply and neatly under the furrow formed by the succeeding plow; and with four oxen or horses, 10 to 12 inches can easily be reached. (*See Transactions of Michigan State Agricultural Society, Vol. iv, p* 147.)

712. Horses cannot draw a plow for any very great distance without stopping. A length of 250 yards is believed to be the best for the size of a field, allowing the horses to rest at the turning. The following table shows the quantities of land plowed at different speeds, at given breadths of the furrow-slices. *(Stephens.)*

Speed; rate per hour.	Distance walked in $8\frac{1}{3}$ hours.		Breadth of furrow plowed	Quantity of land plowed in $8\frac{1}{3}$ hours at that speed.		
Miles	Miles,	Yards,	Inches,	A	R	P
1	8	1248	9	0	3	1
	8	440	10	0	3	14
$1\frac{1}{3}$	12	642	9	1	0	21
	12	220	10	1	0	34
2	17	808	9	1	2	2
	16	880	10	1	2	28
3	26	332	9	2	1	3
	24	1320	10	2	1	42

Table showing the comparative amount of time lost in turnings while plowing long and short ridges. (*Stephens.*)

Length of ridge.	Breadth of furrow slice.	Time lost in turning.		Time devoted to plowing.		Hours of work.
Yards	Inches	H	M	H	M	H
78	10	5	11	4	49	10
149	"	2	44	7	16	"
200	"	2	1	7	59	"
212	"	1	$56\frac{1}{2}$	8	$3\frac{1}{2}$	"
274	"	1	22	8	32	"

713. There are a variety of modes of plowing to suit the nature of the soil and season of the year; though this diversity is more practised in Europe than in America. (For illustrations see *Stephen's Farmer's Guide*, vol. 1 p. 171–186.)

FINIS.

GENERAL INDEX.

[*The figures at the end of each line refer to the Sections.*]

W

ERRATA.

PAGE 62—Reverse the headings of the Table—"Water in the Flour per cent," and "Flour in the Grain per cent."

" 161, line 10 from top, for "Guined" read *Guinea.*

" 166, " 5 from bottom after "Randal Grass" ("*Festuca Pratensis and Elatior.*")

" 181 " 4 from top for "tree" read *tres.*

" 187 " 2 from bottom for "them" read *their.*

" 206 " 13 from top for "soil" read *oil.*

" 250. While the last sheet was going through the Press, the third number of Prof. Johnston's *Chemistry of Common Life* was received, in which it is stated "that the onion is remarkably nutritious. According to my Analyses, the dried onion root contains from 25 to 30 per cent. of gluten. It ranks in this respect with the nutritious pea, and the *Gram* (or Chick Pea) of the East."—*See* § 353, p. 148.